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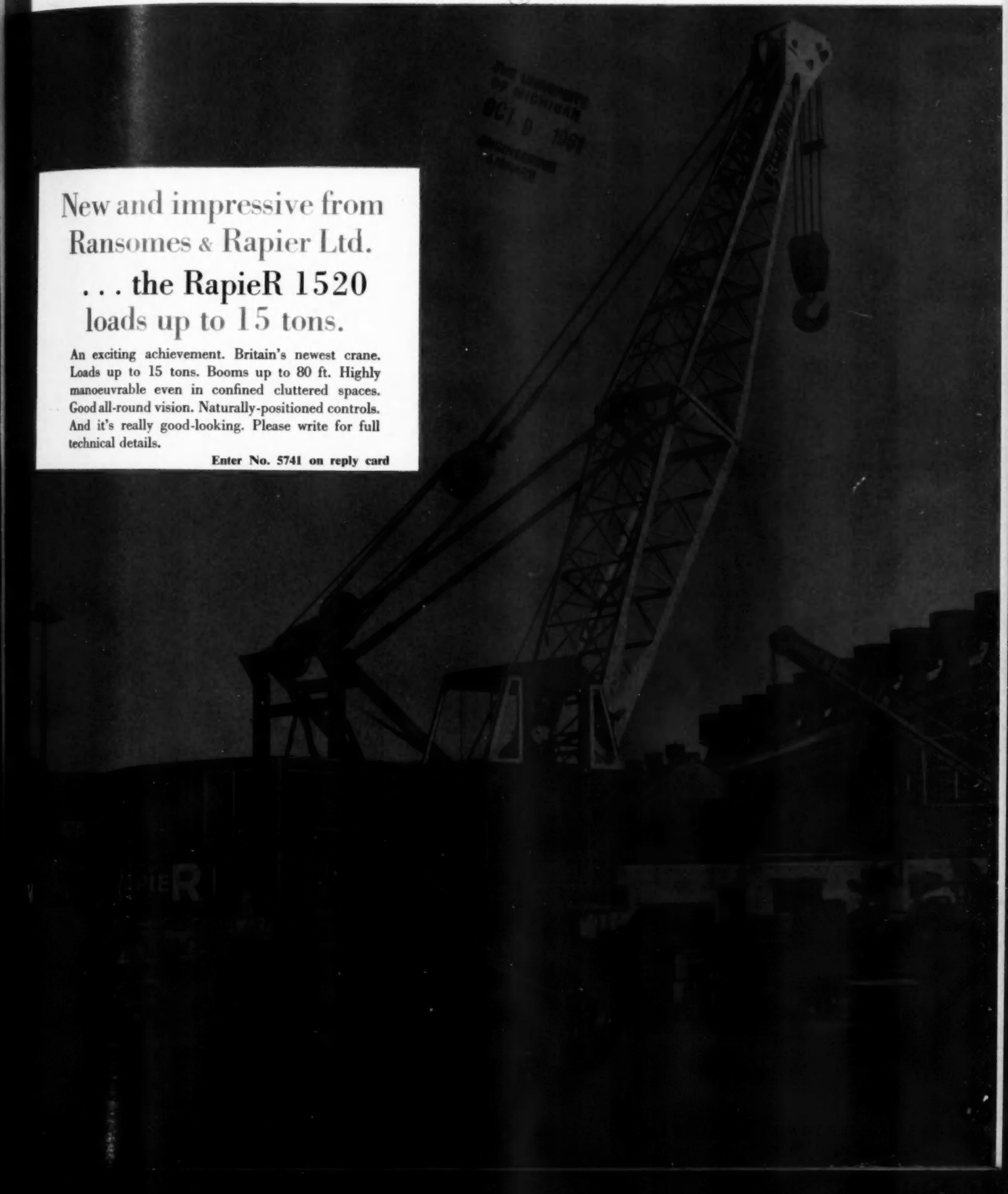

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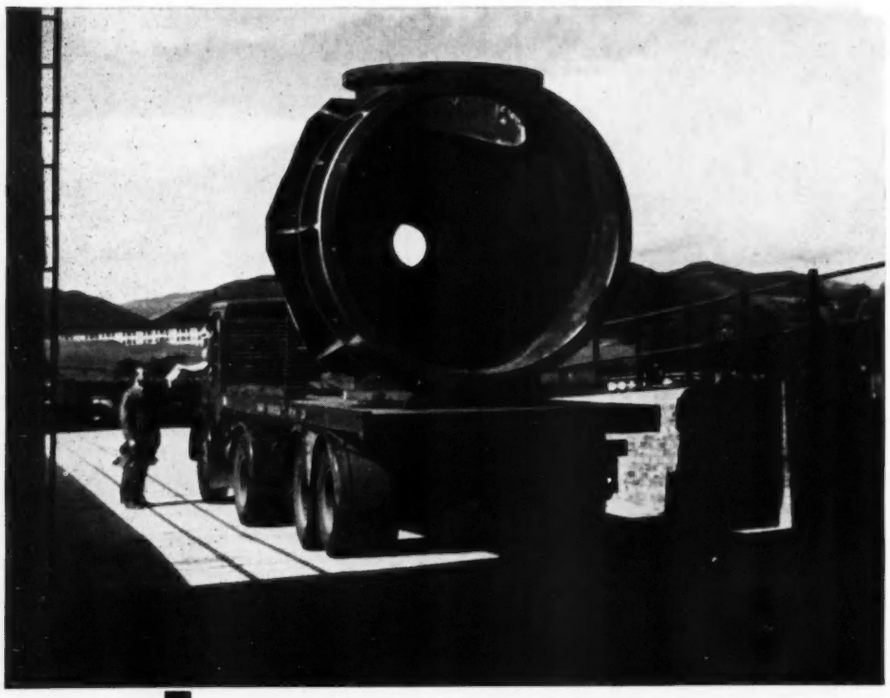

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THE ENGINEER

No. 5512 **SEPTEMBER 15, 1961** Vol. 212

THOUGHTS ON FARNBOROUGH

Even before the Flying Display and Exhibition of the Society of British Aircraft Constructors opened last week, it was overwhelmingly probable that it would not be the most significant of even the purely national aero shows in 1961. This year, the usual complaint that such narrowly exclusive exhibitions give one no chance to assess where one country stands relative to another has, however, been partly vitiated by the fact that the Russian display at Tushino in July proved highly complementary to that at Farnborough. The unarmed subsonic high-altitude bombers which are the only strategic weapon encompassed by British constructors can now be countered economically by manoeuvrable long-ranging re-usable interceptors, of which impressive examples have been evolved in the U.S.S.R. The days of the bomber are now clearly numbered by the rate at which such interceptors can be deployed.

The V-bombers are now envisaged essentially as missile launchers, although it is difficult to reconcile this intention with the apparent lack of interest that has for some years been displayed by the Royal Air Force in its traditional rôle of reconnaissance: if a potential enemy can be sure of not being subject to surveillance, he can then concentrate his defences around targets of known location, such as cities — and, if the missile is of less than the highest accuracy, large cities. On the other hand, by neglecting to exploit the air-portability of its "Thor" strategic missiles, the Royal Air Force has set up tempting targets, and the defence of such highly localised targets cannot pretend to be complete until the Mark II "Bloodhound", which should be able to intercept at low altitudes, is deployed. Both to provide cover at low altitudes and to prevent waves of bombers saturating a semi-active missile defence with only a finite number of target illuminating radars, the Royal Air Force deploys the "Lightning" interceptor of great acceleration and rate of climb, if not endurance; but the "Lightning" is at present armed principally with the "Firestreak," a passive homer which can execute only pursuit course attacks and can therefore be expected to kill only at or near the coast of this country — and only if cloud or rain does not deprive it of infra-red radiation. One sees at once that against such a defence the air-launching of missiles has more than one advantage: it tends to confuse and overload the radar system on which the surface-to-air missiles depend, and it renders the pursuit interception pointless, since by the time the "Firestreak" is launched so also will have been the air-to-surface weapon. These advantages are apparently being exploited as they deserve by the U.S.S.R., since the Soviet bombers, even those with speeds matching that of the "Lightning", have been displayed with winged missiles. In response to this threat the British constructor can suggest only the projected "Red Top" which, by virtue of more sensitive infra-red equipment able to register the hot wakes of powered vehicles and, seemingly, of radar fusing, may be able to make collision interceptions. Had the "Red Top" been ready for service a few years ago, it might have endowed the "Sea Vixen" with an acceptable power of interception, since it is the subsonic fighter which suffers most conspicuously from restriction to pursuit attacks. However, during the week the Royal Navy demonstrated that its strike aircraft could take off straight into low cloud and find (admittedly with co-operation rather than against countermeasures) a ship sailing in visibility of ½ mile under a ceiling of 300ft; if such weather were to occur during operations, the infra-red seekers would be robbed of all value. It is difficult to resist comparison with the U.S.A., where the effort of the industry has been employed to produce weapons which differ in their military as well as their engineering characteristics, so that, for instance, right up to the time of engaging a target a fighter pilot has the choice of radar or infra-red missiles. In theory, of course, the fact that this country has such allies absolves the industry from the need to develop more than a small proportion of the different weapons needed; in practice, it is difficult to be sure that the needs of all the participants in, say, the N.A.T.O. were considered in determining the progress of the Avro "Arrow" or the Bendix "Eagle". Upon the most optimistic view of the meaning of "interdependence" there are likely to be some requirements which allied powers do not share or do not succeed in satisfying.

The posters advertising this year's display were as exciting as ever. But one cannot expect novelty every year — one of the reasons no doubt why suggestions for holding the Show biennially are now under discussion. Besides the Show is a shop-window for the British industry which, no doubt, explains why the "Comet" which has appeared off and on since 1949 can still figure at it. It remains saleable. However, the comment can be made of British civil aircraft that they tend to conform to international ideas rather than to break new ground. It is, of course, not necessarily to be regretted that the exhibitors are following paths well trodden by designers in Czechoslovakia, France, Holland, or the United States of America, but at the same time it makes it more difficult for all concerned to be aware of the real state of the art, and hence does not encourage designers to be daring. One can see that it is attractive to salesmen to be able to say, for example, that Lockheed, Martin, North American, Northrop and Sud-Aviation cannot all have been wrong in putting the power plant aft of the disposable load. But to a particularly influential proponent of fuselage-mounted engines there is attributed a perfectly logical explanation that this configuration exploits a kink, or at least non-linearity, in the F.A.A. requirements, in that the visual minimum conditions for landing are laid down in terms of the number of engines and not of the performance after

engine failure. While the advantages of this arrangement are becoming better understood, it is not so certain that the same can be said of the disadvantages. At least one design, for which it must have been particularly difficult to choose a single optimum by-pass ratio because it mixes podded and buried engines, has turned out to have different power unit assemblies for each engine location. It seems not to have been possible to gain reliability for the accessories by having common drives from clustered engines, while it may well have been the doubt that such engines were independent that led the Air Registration Board to ask for the ability to go round again with more than one engine out, a case which, it has been proved, can design the aeroplane. Even if a study of past struggles with the "square-cube law" were not by itself enough to cast doubt on the proposition that the largest and the smallest civil jet aircraft in the country should be the same shape (at scales differing by 4:1), one can very reasonably express alarm that so many branches on the tree of experience are being trained away from the direction so long advocated by the aerodynamicists, that of integrating lift and thrust-producing elements.

BRITISH ASSOCIATION AT NORWICH

It was at Norwich that from August 30 to September 6 the British Association for the Advancement of Science held its 1961 summer meeting, a report upon which is printed on another page of this issue. But, of course, the programme is little influenced by the venue of the meeting. Indeed, some of its critics might mischievously suggest that it is not very much influenced by anything, not even the progress of science! In fact, however, that criticism, once perhaps pertinent, is now, we think, out of date; the association is changing and changing in many respects for the better. There was a time, not long ago, when the papers read before the various Sections into which the Association is divided tended to be abstruse and specialised; unfortunately, they were also not recording anything which was new. For those of the Association's members who read papers before it are almost all also members of other learned societies at whose premises it is more appropriate that they should present learned papers on specialised subjects containing real contributions to new knowledge. Those who organise the proceedings of Section G (Engineering) for example, cannot hope to attract contributions of the kind much more appropriately presented before one of the major engineering institutions; nor, since the audience at a Section G meeting is unspecialised and is likely to include numbers of young students and even, as we discovered at Norwich, sixth form children, can it be expected that there will be any deeply technical discussion. That point, it seems to us, has now been grasped by the Association as a whole, not by Section G alone. There is a trend towards the presentation of papers of two kinds, those which present specialist subjects to audiences composed of scientists specialising in other fields and those which discuss quite broad scientific subjects before audiences interested in, rather than necessarily practising, science. The purpose of the annual meeting has thus become the presentation of science to scientists and the explanation of it to the public at large. The latter object is now specifically pursued by the presentation, during a meeting, of popular lectures and the showing of scientific films.

A growing perception of the new practice amongst those who attend meetings is now leading to what may be regarded as a very desirable consequence. More and more of the members are tending, not so much to lose interest in what their own specialised Sections are doing, as to be attracted to attend more of the meetings of other Sections; and more and more frequently, we fancy, two or more Sections will join together to hold a joint meeting. For engineers nothing we feel could be more desirable; because Section G bears a special relationship to all the others running from A to N. It is not alone amongst the Sections in representing the application of science; but it is alone amongst them in being primarily interested in that application. Thus an engineer necessarily finds that at each meeting of the Association much that is going on in other Sections is of interest to him. We were pleased to note at Norwich the extent to which Section G held joint sessions with a number of other Sections, including Section M (Agriculture), Section D (Zoology), Section E (Geography) and Section A (Mathematics and Physics). For the kind of paper which can be presented before Section G more appropriately than before any other body is one that puts into the heads of engineers and particularly the heads of youngsters (who compose a substantial part of the audience) ideas as to how specialist scientific discoveries are being or might be applied by engineers for the general benefit of mankind.

The Engineer—100 Years Ago (SEPTEMBER 13, 1861)

"CANAL TUNNELS AND STEAMBOATS"

"For some weeks past several of the boats on the Grand Junction Canal have been propelled by steam instead of being drawn by horses, and with proper adaptations of the tunnels, &c., there is no doubt that the difficulties hitherto experienced in navigating canals with steam-boats are in a fair way of being overcome. There are several tunnels on the canal, one at Agar Town, and another, the one in which the melancholy occurrence we are about to detail occurred, being close to the Blisworth station on the London and North-Western Railway. The canal tunnels are made of brick, and are little, if at all, larger than a sewer. The tunnels are so constructed that horse-power is of no use, previous to the introduction of steam the boats being propelled by a process called 'legging.' The process is this: A board is placed out on either side of the boat, and on each boat lies a man who places his feet against the wall of the tunnel and thus pushes the boat along.

"The engine, however, is not without its disadvantages, for, as the tunnels are long, and, as we have said, no larger than sewers, the boatmen are half-stifled by the volumes of carbon that are emitted from the low funnel; coal being burnt instead of coke. On Friday night two steamboats entered the tunnel, and before they again emerged from it the people in them were rendered insensible by the fumes from the engines, two of the men being quite dead, and one of them fearfully burnt by falling, while insensible, on the engine."

S.B.A.C. Exhibition, 1961

(No. II—*Continued from page 399, September 8*)

The twenty-second Flying Display and Exhibition of the Society of British Aircraft Constructors concluded last Sunday. The flying display was provided very largely by the fighting services, and at right there can be seen formations of "Sea Vixen" and "Scimitar" aircraft, followed by "Gannet" airborne early warning posts, while a "Scimitar" has just engaged with its hook the wire of the runway arrester and the nylon bands are unwinding from the braked drums.

THE evolution of new engines appears to be concentrated rather heavily on jet engines suitable for aircraft performing vertical take-off and landing. On the stand of Rolls-Royce, Ltd., there appeared an RB-145 lightweight jet engine with afterburner; our illustration shows that this method of thrust augmentation results in a considerable increase in the volume of the engine. It can be seen that the engine is pivotally mounted, which may well be in order to enclose it within a streamlined body during normal flight; proposals for rotating complete engines from horizontal to vertical are of course extant, but have involved moving a complete nacelle and not an engine alone. However, it could well be that a machine with separate lift and thrust engines might use identical engine units in each application and have reheat on the thrust engines in order to save weight.

The dummy descending after a demonstration of the Martin Baker "zero-zero" ejector seat. To protect the seat itself for use again, it is attached to the dummy

On the same stand the "Spey" engine was shown in a more detailed form than last year. The engine unit displayed was notably asymmetrical, and it appears that the D.H. "Trident" will have similar basic engines built up differently for each of its three positions (since two of the engines are podded and one buried, it would appear that different by-pass ratios would be optimal, but this is not achieved). The need to hold spare engines for each position may appear extravagant, but since the "Trident" is a short-range machine the operators are presumably able to afford the time to ferry engine-out to one of few maintenance bases. It is interesting to notice that while the by-pass principle endows the low-pressure compressor with a favourable operating line, the by-pass ratio of the "Spey" is so high that the optimum pressure ratio of the high-pressure compressor is high enough to demand variable-stagger inlet guide vanes.

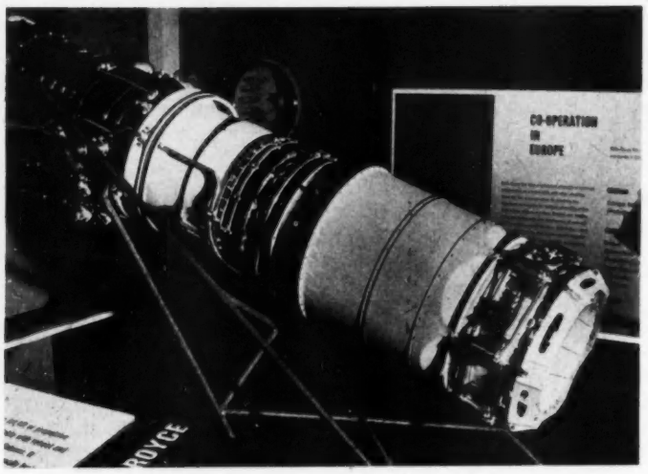
The problem of starting gas turbines continues to evoke numerous solutions, and Teddington Controls, Ltd., showed one of the most radical in the form of a complete gas turbine, with an electric starter motor, to act simply as a starter for a large engine. The example illustrated, the Noelle 60, gives 55 h.p. and weighs 55 lb; it is described as the lightest aircraft engine starter in the world. The difference between this method and the better known one of bleeding air from an auxiliary engine is that the elimination of any ducting means that far higher gas temperatures are feasible, but of course the ability to start a plurality of engines is sacrificed and it is not possible to use the auxiliary to drive, say, an electrical generator. The little free-turbine engine is shown as installed on a S.N.E.C.M.A. "Atar"; it can be seen that the exhaust gases are discharged into the main compressor intake.

At the opposite end of the spectrum of starting aids is that developed by A.E.I., Ltd., which dispenses with the expensive prime movers necessary for starters running on air. The A.E.I. equipment supplies the normal low pressure starting turbine of the aircraft engine with steam, and the greatly reduced power demand of the feed pump allows the entire equipment to be mounted, as seen overleaf, on a "Land Rover." The steam is generated in a flash boiler, and since there is no requirement to maintain pressure at low flows, as with a piston engine, the supervisory gear is very simple, taking the form of a steam temperature control of fuel flow and a blow-off valve to limit pressure. The unit illustrated delivers 1·2 lb per second of steam at 160 deg. Cent., and will accelerate a "Conway" or "Olympus" in 20 seconds. The principal appeal of this system is of course low cost, and the figure claimed is 1s. 9d. per engine.

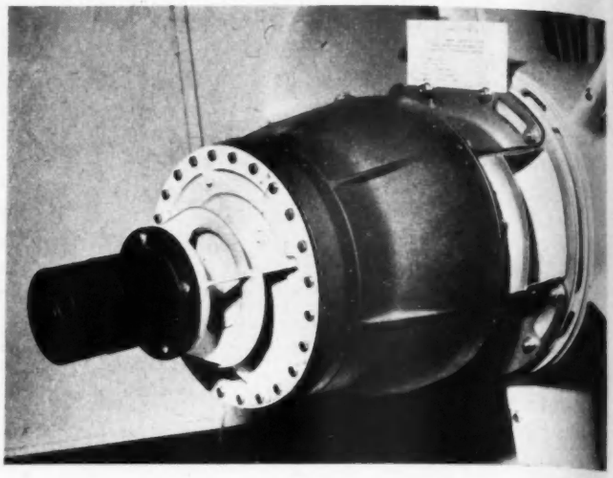
Electronics and Communications

It was stated during the exhibition that exports of aviation electronics now amount to roughly half the total exports of electronic capital equipment. The computer is assuming increased importance in control and airborne applications, and the first Ferranti "Apollo" for air traffic control completed its acceptance trials some three weeks ago. It is now working at Prestwick, where the intention is to use it alongside normal manual procedures in order to determine how computing may best be fitted into the system. One investigation is to find out to what extent and how quickly the separation of air movements might be reduced. On the airborne side the future is expected to lie with the digital computer, since analogue computing has limitations in this field, among which is the fact that time-sharing cannot readily be arranged. A digital computer operating on the time-sharing principle provides virtually simultaneous solutions of very large numbers of problems. The present objective in computing, both ground and airborne, is to leave the man in the system as the taker of decisions, but to present him with data in a form which previously he could only arrive at by his own efforts, and at the expense of encroachment on his decision-taking capacities.

Work on development of the "Autoland" blind landing system is being concentrated on the ground equipment for azimuth guidance, and there are prospects of improved radio devices for this purpose. A few experimental automatic landings have been made with the aid of final azimuth guidance from leader beacons producing beams modulated similarly to the signals from the leader



The after-burner of the RB-145, a jet engine of 2750 lb thrust and a thrust-weight ratio greater than 9. In the background can be seen the mixing nozzle of the "Spey" by-pass engine



A self-contained free turbine engine with a full annular combustion chamber is seen here mounted in the intake of the engine which it starts through two stages of epicyclic gearing

cables of the existing system. "Autoland" is to be evaluated for the F.A.A., and a DC-7 is being equipped for this purpose.

Reflecting the interest in computers mentioned above, the Decca Navigator Company, Ltd., showed its "Omnitrac" for the first time. "Omnitrac" converts fix information expressed in hyperbolic co-ordinates into rectilinear terms, enabling charts with normal lattices to be used in the Decca Flight Log. The computer is based throughout on proven digital techniques. It is contained in an Arinc case of the 1-ATR size measuring approximately 10in by 20in by 8in, and an additional ½-ATR container is required for the power unit. In addition to operating the Flight Log, the computer will drive an indicator showing continuously range and bearing to any desired point in the Decca coverage, the co-ordinates of which have been fed in. Flight Logs used in conjunction with an "Omnitrac" computer can be fitted with a digital servo system controlling the pen so that the latter automatically takes up its correct position on the chart at the beginning of a flight. This self-setting Flight Log is known as the Mark 3.

Decca Radar, Ltd., showed a transistorised display and data handling system, T.D.5 Mark V, in which an integral liquid cooling system maintains all circuits at a constant temperature and controlled humidity, enabling transistors to be used in circumstances requiring high performance and stability. Stable temperature, controlled to within $\pm 0{\cdot}25$ deg. Cent., is maintained throughout a cabinet group in ambient temperatures up to 45 deg. Cent. The equipment meets military and civil operational requirements from simple displays from a single radar input to complex data handling systems employing digital computers, with multiple radar and other data inputs. We illustrate the central display drive installation, comprising three electronic cabinets and a power and coolant cabinet (lower right). Each electronic cabinet contains three assemblies of basic transistor circuit boards which are interconnected as required, the complete unit, or module, being capable of operating twenty-six displays. Separate 12in diameter viewing units are suitable for console or table top mounting and are fully transistorised except for the c.r.t. and e.h.t. rectifier. Performance requirements do not usually call for full environment stabilisation of these units but a heat exchange method is employed whereby cooling liquid is circulated through cold plates containing the printed circuit boards. A small fan and radiator exhaust surplus heat from the rear of the unit.

The electronic and the power and coolant cabinets of the system were developed by Decca in conjunction with Precision Reinforced Mouldings, Ltd., Tolpits Lane, Watford, by whom they were manufactured. They consist of polyester resin reinforced with glass fibre completely surrounding a light alloy frame, and are able to withstand 30*g* loads. A rigid foam infilling increases the thermal insulation. This construction was chosen to provide great strength with low thermal conductivity in minimum space. As will be seen from the illustration, the module is made in one piece. With each one is a cold plate frame, three covers and a door.

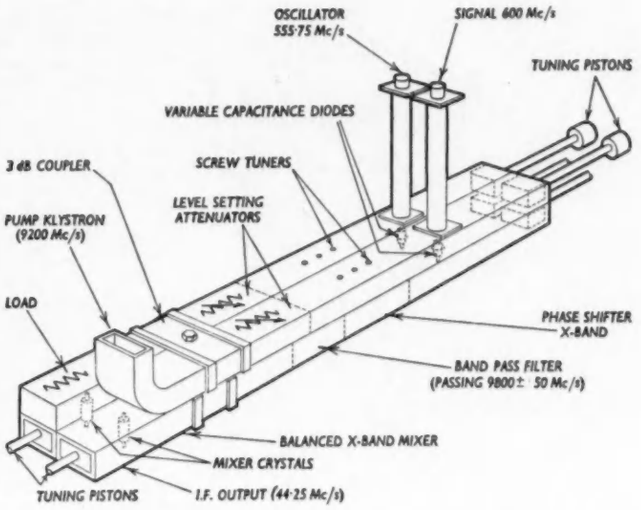
Radar display and data handling system with transistor circuits in temperature- and humidity-controlled modules

Mobile steam generating unit for aircraft engine turbo-starters, mounted on a "Land-Rover"

The cold plate frame consists of three open plates which house the printed circuit boards. Each plate contains the ducts carrying the cooling liquid and has a heated blanket as a surround. Flow of coolant to the ducts or power to the blanket is controlled by a temperature-sensing system in each cold frame. Printed circuit boards are mounted in a metal surround which is in good thermal contact with the frame.

Developments in methods of displaying radar and air traffic control data were among the exhibits of Marconi's Wireless Telegraph Company, Ltd. The console illustrated contains the new SD.1015 12in P.P.I. tube, the SD.1016 tabular display unit, and a screen for presenting meteorological informa-

Controllers' suite with c.r.t. presentation of radar/synthetic information and flight data, and closed circuit television for weather information



Arrangement of experimental parametric amplifier with variable capacitance diodes for radar

tion received on closed-circuit television. A dual-deflection system in the SD.1015 incorporates a linear voltage-current converter for main radar sawtooth sweep, and a high-speed writing deflection circuit with wider bandwidth to facilitate presentation of alpha-numeric target markers. Radar and synthetic display facilities are thus shown on the same tube. Three design techniques employed to achieve these results in a unit measuring only 14in high, 14in wide and 28in long

Aerial site installation of Doppler ground d/f system, comprising rotating aerial and receiver unit

are : (1) retention of the conventional low-current timebase for the P.P.I. timebase trace ; (2) incorporation of boost circuits which automatically come into action only when a fast transition of the electron beam from one point on the tube face to another is required.—as the boost facility is a transient, large valves are not required ; and (3) incorporation of a separate amplifier and coil assembly to initiate the very high speeds demanded in the symbol writing process.

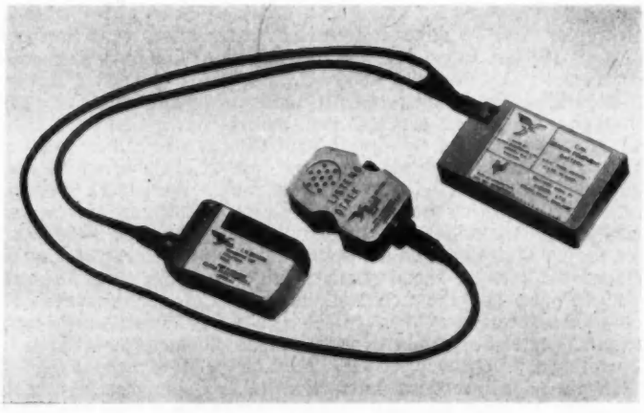
The SD.1016 unit is part of a tabular display equipment for presenting information from an air traffic control or similar computer or data processor. Such information is

Transmitter/receiver of lightweight v.h.f. equipment. Crystals for 400 channels are housed inside the selector knobs

passed to a buffer store in the control unit of the tabular display equipment where it is retained until modifying instructions are received. The stored data is scanned sequentially at a rate determined by timing circuits and when called up by operation of switches on the operator's desk is fed out to control an electronic character generating device which provides the waveforms required to produce alpha-numeric symbols on the display unit SD.1016.

The displayed picture consists of symbols or alpha-numeric characters arranged in a series of horizontal lines across the cathode ray tube face. The individual character is written by continuous movement of the electron-beam spot through the intersections of a four-unit by four-unit grid or matrix. Four hundred characters written on the 7in by 5in screen are easily readable at a viewing distance of 2ft to 3ft, in normal room lighting conditions. Each character is written in 20 microseconds. As the central unit of the complete equipment is capable of delivering 50,000 characters per second, the use of time-sharing techniques permits the feeding of a number of SD.1016 displays, each exhibiting completely different and independently controlled information. In a typical application ten displays each presenting 250 characters at a rate of 20 frames per second are fed from one unit.

On the components side, the Marconi company this year showed a parametic amplifier operating on the variable-capacitance diode principle, which has been designed by the company's research laboratories as a low-noise amplifier for use with the company's S.264 series of surveillance radars. The amplifier is of the " up conversion " form, the pump frequency applied to the diode being about fifteen times the signal frequency. The latter, in the pumping process, is " up-converted " to a frequency which is the sum



All-transistor miniature radio beacon with speech facility

Doppler drift unit for use with weather radars in aircraft. Drift angles are read from the calibrated scale after adjustment of the c.r.t. display

of the two ; this arrangement has certain advantages over the negative-resistance type of amplifier in that, when used in conjunction with a mixer, as in this instance, the stability of the klystron pump is not nearly such an important issue, any variations in pump frequency being cancelled at the mixer stage.

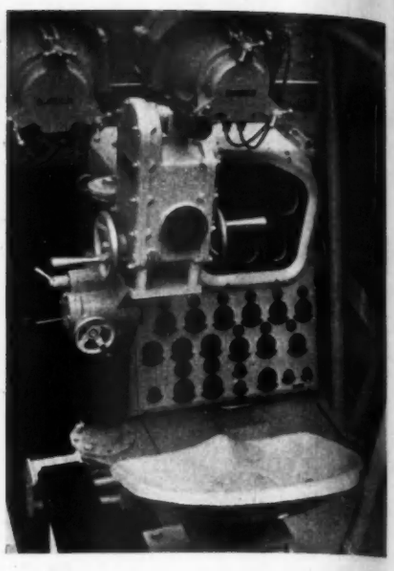
In the Marconi amplifier (illustrated diagrammatically), the pump source is an English Electric klystron oscillating at 9200 Mc/s. The output from this is fed along two separate sections of waveguide via a 3dB directional coupler to provide equal power in both arms ; each section embodies a variable attenuator and a three-screw tuner and, towards the far end, a variable capacitance diode.

Each diode is so mounted as to protrude through to another waveguide section, mounted flat-on underneath the first so that there are, in fact, in the entire assembly four waveguide sections, two lying parallel to each other at the top of the structure, and two similar ones underneath. Into one diode is fed the 600 Mc/s signal via a low-pass filter to isolate the external signal source from the pump frequency ; the second diode is also connected through a low-pass filter to an external crystal-controlled local oscillator operating at a frequency of 555·75 Mc/s.

In the signal section, interaction takes place in the diodes between the 9200 Mc/s pump frequency and the 600 Mc/s signal, with consequent transference of power from pump to signal. Along the lower waveguide section is now flowing a wide-band signal consisting of the pump frequency, 9200 Mc/s, and upper and lower sidebands extending to 9800 Mc/s (pump + signal) and 8600 Mc/s (pump − signal) respectively. After passing through a varactor the signal is fed through a band pass filter centred on the sum frequency (9800 Mc/s) and with a pass-band of ±50 Mc/s. This accepts this band of frequencies and passes them to the mixer section ; it also " traps " the lower sideband which is used for providing a degree of regeneration.

The local oscillator section is similar except for the different frequencies involved ; in this instance the local oscillator frequency is 555·75 Mc/s and the upper and lower sideband limits 9755·75 Mc/s and 8644·25 Mc/s. Again a bandpass filter in the waveguide accepts the 9755·75 Mc/s signal. Each signal (9800 and 9755·75 Mc/s) passes through an arm of a 3dB coupler to a balanced mixer stage consisting of two crystal diodes, and the resultant beat or difference signal is extracted as a 44·25 Mc/s intermediate frequency. The ends of the waveguide sections each terminate in cavity tuners.

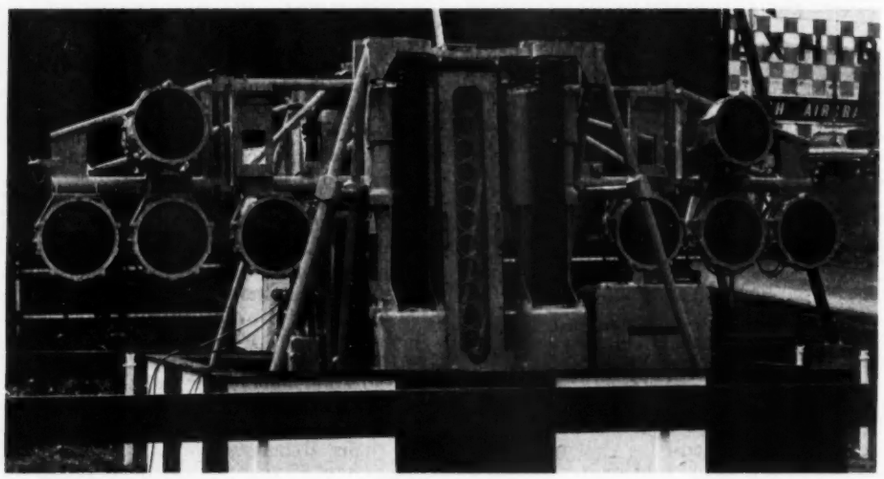
Application of the Doppler principle to ground d/f was demonstrated by Standard Telephones and Cables, Ltd. The equipment provides bearings for any aircraft capable of r/t communication in the civil aviation v.h.f. band, 118-136 Mc/s. To produce the Doppler effect, the aerial system of two dipoles, on a 12ft cross-arm under the resin-bonded glass fibre radome seen in the illustration, is rotated at three revolutions per second. The essence of the system lies in the methods developed for satisfactory detection of the effect at a practicable speed of rotation, combined with a wide-aperture aerial which is claimed virtually to minimise unwanted reflections. At 125 Mc/s the aerial baseline is equivalent to 1½ wavelengths. The receiver is housed in a cast-iron weatherproof cabinet at the aerial site and is connected to electro-mechanical bearing indicators in the control tower. Indications are given by lights shining through an apertured disc which are switched on automatically when the equipment locks on to a signal strong enough for satisfactory bearings. The indicators have a dead-beat action and a response time of 1 second. Both the aerial and control tower apparatus have been designed for servicing by non-specialist personnel. The aerial site equipment can be supplied with full weather protection for all climatic conditions. This navigational aid is aimed particularly at the smaller airfield, faced with growing traffic and the problem of providing accurate and dependable service without acquiring specialist maintenance and operating staff.



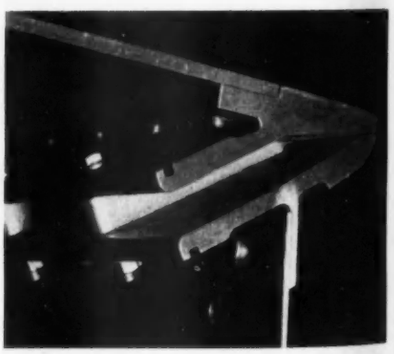
Control position of deck-landing projector sight

While the growing use of light aircraft for " executive " travel and the like increases the demand for ground navigational aids such as the Doppler system described above, the aircraft themselves call for new ranges of communications equipment tailored to their dimensions and capacities. Standard Telephones and Cables also showed an airborne v.h.f. communication and navigation system for this field in which the basic unit is a transistorised transmitter/receiver measuring only 5¾in by 3¾in by 8in deep. This can be used to drive amplifiers giving 6W or 25W output. A matching radio navigation system in three units is available. The communications equipment has 400 switched channels, the crystals for which are contained within the switch knobs seen being adjusted in our illustration of the transmitter/receiver. The holders are segmental so as to form a circular " stack " within the knobs, where they are fully protected but can be removed without opening the case.

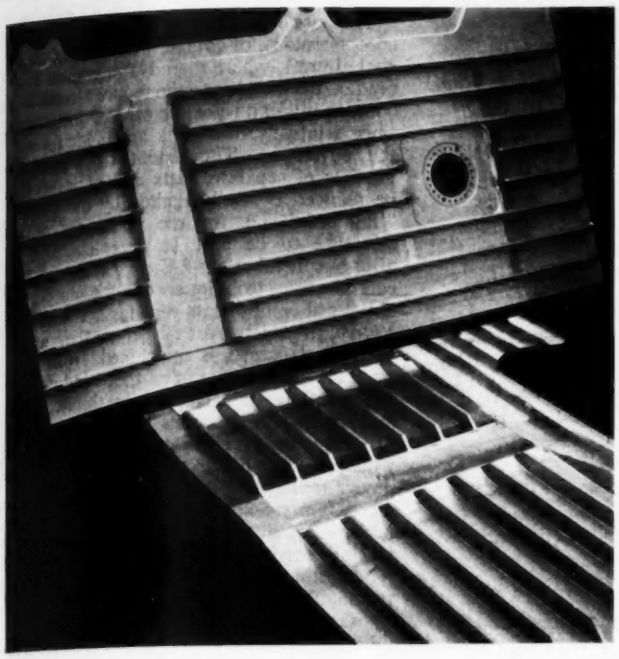
A stable platform being developed for the Ministry of Aviation for navigation systems in aircraft was shown by Ferranti, Ltd. The inertial platform, which is fully manoeuvrable, carries three accelerometers and is stabilised



Deck-landing projector sight, showing datum lights to right and left of the twelve projectors



Light alloy sections assembled to form a slit at the upper edge of a wing immediately forward of the flap : air is supplied by a part-circular duct clamped into the grooves on the webs



Integrally stiffened panels for the VC-10 : the further panel has had the machining marks polished out in a bed of limestone chips

Intake section of nacelle of Bristol 188 : the spot welds were made by an argon-shrouded arc-fusion process that can be performed in confined spaces

by three flotation type gyros. Synchros on the gimbals supply attitude and heading information, and inertial velocity is derived by integrating accelerometer outputs. Stabilisation of the vertical axis is by two miniature gyros, made by The English Electric Company, Ltd., under licence from the Minneapolis Honeywell Regulator Company in the U.S.A. The azimuth performance enables accurate heading information to be available for several hours without monitoring by external means, provided the necessary corrections are applied, and is achieved by a Kearfott 2502-3D gyro manufactured under licence by Ferranti, Ltd. in Edinburgh. Kearfott single-axis force-feedback accelerometers are manufactured by the company's Manchester factory. The principal electronics for controlling the inertial components are built on the gimbals, thereby reducing the number of slip-rings and increasing reliability. Size and weight of any external electronic units are also reduced by this principle of contruction. The azimuth, inner roll, and pitch gimbals are controlled by gyro pick-off through geared induction servo-motors. These are of low power consumption, enabling the low-power servo-amplifiers to be mounted on the platform, thereby reducing the number of sliprings.

The platform can be used in combination with Doppler radar, the quality of the heading output allowing accurate navigation for long periods. It also has short-term inertial navigation capabilities for periods when the Doppler is inoperative, and provides accurate pitch and roll data, unaffected by aircraft manoeuvres. The platform is a completely sealed unit filled with an inert gas and fully temperature controlled. Cooling is provided by a heat exchanger arranged round the sealed unit. Overall dimensions are length 23½in, diameter 12½in approximately, and weight 85 lb, including the computing apparatus.

Ferranti, Ltd. also showed a warning system which can give any one of fifteen warnings when triggered by sensing apparatus placed at strategic points in engines, fuel system, hydraulics, controls, and so on. Warnings are given priority according to their significance. The most important signals will be repeated continuously until they are manually cancelled by the pilot, and they take priority over ordinary signals, which are repeated three times. All warning signals are superimposed at high level over any other communications.

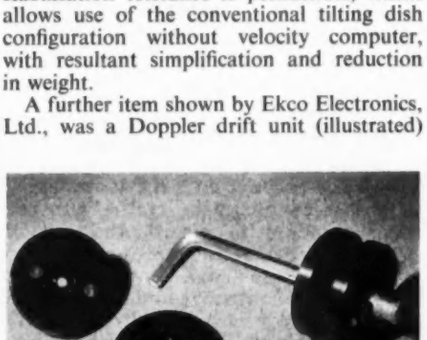
The audio warning unit consists of a tape transport mechanism and a selector switch which continuously samples the warning circuits. When one of the circuits becomes active, the switch automatically connects with the appropriate tape track and switches on a playback amplifier. Warning messages are pre-recorded on a 9in loop of sixteen-track magnetic tape, one track being used for tape indexing and the other fifteen for warning messages. The unit is hermetically sealed in a 4¼in cylinder, 10in long and weighing 6 lb.

An all-transistor miniature distress beacon operating on 243 Mc/s, particularly for air/sea rescue operations, was shown by Ultra Electronics, Ltd. It comprises the three units shown on p431, from left to right the beacon speech unit (optional) and battery unit. An omnidirectional aerial of spring steel strip is normally coiled round the beacon unit, and when erected releases a cam-operated switch which brings the transmitter into action. The signal consists of a carrier modulated by a 1020±25 c/s tone (square wave). When the speech unit is supplied, the beacon contains transmitting and receiving circuits, and the speech unit has a talk-listen switch which cuts out the tone in the " talk " position. Range of the beacon is 60 nautical miles to an aircraft at 10,000ft, or five nautical miles to a surface vessel, and speech range is not less than the nautical miles. Total weights of the system are 46 oz with speech facility or 36 oz without.

The interest in " executive " aircraft this year was reflected in many items of equipment, among which a new weather radar scanner for installations where nose space is limited was shown by Ekco Electronics, Ltd. The unit has a two-axis scanner with an 18in dish, or a 12in dish to reduce the swept volume in smaller aircraft. For further economy in nose space, the servo amplifier is mounted separately. The layout has been arranged to permit the gearbox and connections to lie almost entirely within the swept volume of the 12in dish, thus economising in installation space.

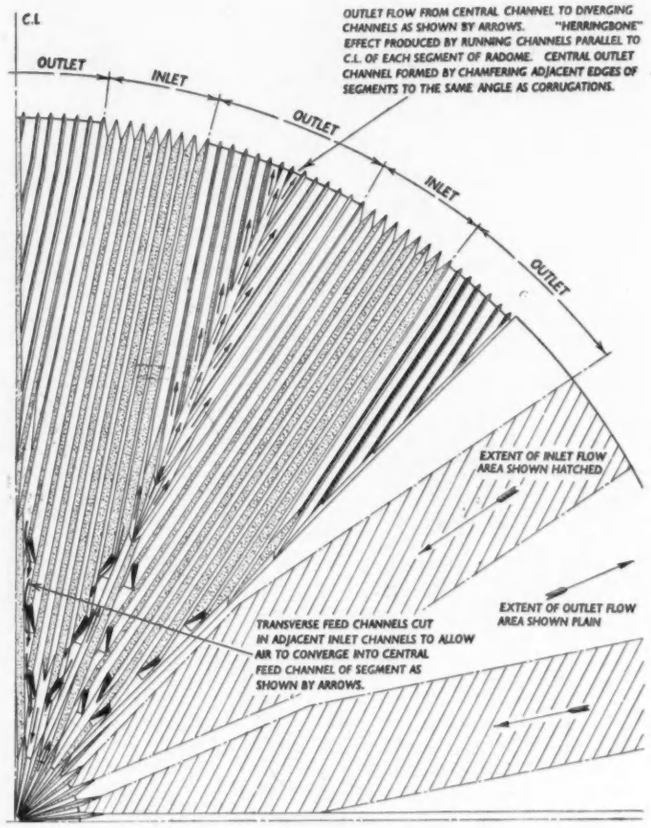
The antenna scans 72 deg. in azimuth, and for installations where the space available is limited, this angle may be reduced to 60 deg. Scan frequency is 50 scans (25 cycles) per minute. The scanner is line-of-sight stabilised, using stabilisation reference information from any of the standard remote gyro systems. With the wider beam widths resulting from the use of 12in and 18in antennae, a somewhat larger stabilisation tolerance is permissible, which allows use of the conventional tilting dish configuration without velocity computer, with resultant simplification and reduction in weight.

A further item shown by Ekco Electronics, Ltd., was a Doppler drift unit (illustrated)



Stress-carrying panel fastener that will engage despite misalignment up to 0·006in

which may be used with any of the company's E190 weather radars to provide measurement of drift angle. The drift angle is measured by stopping the normal azimuth movement of the scanner and varying the antenna azimuth angle by a manual adjustment *via* a small servo housed in the drift unit. With the antenna stationary, the received signal will contain a multiplicity of reflections from all point targets within the beam-width. These multiple reflections give rise to a Doppler beat component in the received signal which appears in the receiver output as a video spectrum in which major components occur at frequencies between 1 and


C.L
OUTLET FLOW FROM CENTRAL CHANNEL TO DIVERGING CHANNELS AS SHOWN BY ARROWS. "HERRINGBONE" EFFECT PRODUCED BY RUNNING CHANNELS PARALLEL TO C.L. OF EACH SEGMENT OF RADOME. CENTRAL OUTLET CHANNEL FORMED BY CHAMFERING ADJACENT EDGES OF SEGMENTS TO THE SAME ANGLE AS CORRUGATIONS.
OUTLET
INLET
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EXTENT OF INLET FLOW AREA SHOWN HATCHED.
EXTENT OF OUTLET FLOW AREA SHOWN PLAIN
TRANSVERSE FEED CHANNELS CUT IN ADJACENT INLET CHANNELS TO ALLOW AIR TO CONVERGE INTO CENTRAL FEED CHANNEL OF SEGMENT AS SHOWN BY ARROWS.

Developed view of a conical radome with internal air passages

20 c/s depending on beam width and ground speed. These beats can be resolved on the "A" scope display, giving a clearly recognisable flutter which is of minimum amplitude when the antenna is pointing in the direction of the true ground track. Thus when the antenna azimuth angle is adjusted for minimum flutter, the transmitter beam lies along the true ground track and the drift angle can be read directly from the calibrated scale. The unit contains a 1½in by 3in cathode ray tube which provides an "A" scope display of the received signals, and a transistor servo amplifier to control the azimuth position of the antenna over a range of ±40 deg. on dead ahead.

Two illustrations are reproduced of a deck landing projector sight shown by the General Electric Company, Ltd. This unit has been developed by the company's Hirst Research Centre in conjunction with the Admiralty. The optical system consists of a vertical bank of twelve precision projectors, each giving a beam of very small vertical spread. Horizontally the beams are spread over 40 deg. so that the pilot can pick up the indication as he turns on to the final approach. In the vertical sense the twelve beams are set at intervals of 8 min. of arc, so that the total vertical spread is about 1½ deg. A pilot sees two lights at a time, appearing as a single orange light which moves up and down relative to the two "side arms" of three green datum lights. When the orange light is aligned in the centre of these, he is on the correct glide path. The sight is gyro stabilised and can be raised and lowered by means of an 11 h.p. motor to allow for pilot height in different aircraft. Useful range is approximately 1½ miles. At 400ft a pilot can detect an error of 1ft from the correct glide path. Two red "wave-off" lights are provided. Special precautions in the form of a fan heater air circulation system and silica-gel dessicators have been taken against condensation in the projector system.

Among the many components exhibited, a display of wires and cables by British Insulated Callender's Cables, Ltd., showed a self-bonding enamelled winding wire, "Bicaloc," for coils of awkward shape in radio equipment and small electrical apparatus, where space limitations prevent use of a former or core. The wire may be bonded by passing a current through the completed coil after winding so as to give a mean temperature rise of 130 deg. Cent. For larger coils heating in an oven may be necessary, or in certain fine wire applications the wire may be brought to the bonding temperature by heating the final winding pulley electrically so that the turns bond together during winding.

Airframe Construction

Several exhibits illustrated relatively new methods of construction which have been tried or even accepted. We illustrate the trailing edge of a section of wing built in the development of the Blackburn "Buccaneer," an aircraft which, it will be recalled, employs boundary layer control by blowing over the flap pivot and the wing upper surface. It should perhaps be interpolated that the actual Naval aircraft, as exemplified by that in the static park, have the boundary layer control system integrated with the de-icing, or rather anti-icing system, in that the hot bleed air passes along the extreme leading edge; on the aircraft displayed the ducts were of stainless steel, left unpainted. This aircraft, being required to fly consistently fast and low, has a structure dominated by the need to withstand gust loading, and it will be seen that the wing is assembled from large light-alloy machined components, and is not "skinned" in the usual sense. The rib member is machined out of a slab, but it is mentioned that forgings were originally used for this component.

The use of large machined light-alloy components is, of course, well established on civil aircraft, where the advantages are more predictable life (due to the reduced number of components) and greater ease of inspection, since relatively few parts are hidden within the envelope. The extent to which the number of separate parts and of joints can be reduced is finally limited by the need to "fail safe," i.e. for the remainder of the structure to be able to complete a flight after one member has failed. An aircraft that carries the technique of "sculpturing" structural components very far is the Vickers VC-10, in which over 50 per cent by weight of the structure is machined from solid metal. As an example, the windows are cut out of deep panels which are thinned down away from the apertures themselves, instead of there being separate frames for each window. Our illustration shows two VC-10 panels that were displayed at the exhibition, one after machining and the other after polishing in a "shuffle box" (oscillating in a bed of limestone chips) and protecting with "Alocrom." The integral stiffeners are rectangular in section because they are formed by gangs of edge mills; the largest of the milling machines used, a Marwin, can excavate as many as six of these stiffeners at a time with a depth of cut of 0·9in and a feed of 21ft per minute. The general accuracy of such panels is 0·005in over lengths as great as 33ft. Not only is it necessary to inspect slab intended for such treatment minutely, to ensure that any defects present will be removed, but for the lighter panels, which may be reduced in weight by 90 per cent, stress relieving by stretching may be necessary to achieve stability. The Vickers method of forming the lighter panels to aerofoil contours

Face and reverse side of electro-luminescent instrument dial: at the top of the panel is a flexible strip of luminescent material

is to shot peen the convex face, so that a compressive stress is present in the outer layers.

The methods discussed above are applicable, in general, to low density materials only, although the VC-10 does use machined steel components for such heavily loaded parts as the beams carrying the clustered engines. When high strength materials are used the "traditional" methods of fabrication from rolled products must persist. The Bristol T.188 supersonic research aircraft is built of

stainless steel to resist kinetic heating, and hence sections are generally light and methods of joining important. There was displayed a strain-gauged engine nacelle intake section illustrating how this somewhat complex structure had been assembled by the technique of puddle welding or argon-arc fusion spot-welding, which has nothing in common with conventional resistance spot-welding.

The heat-source in puddle welding is an arc, struck between a non-consumable tungsten electrode as negative and the workpieces to be welded as positive. The complete welding-cycle is carried out in an argon atmosphere, localised by a shroud or shield. Pressure between the surfaces of the two components of the workpiece need be sufficient only to ensure intimate contact during the period of fusion and solidification, and can be applied by manual or mechanical means, via the medium of the shroud or gas shield.

The convoluted configuration of this p.t.f.e. hose allows it to be compressed for access to the cables within

Because of the nature of the process, that is complete melting through the upper sheet of the workpiece and the lower one, it is applicable to lap welding but not to butt welding. The need for backing-plates during welding is determined by the stiffness of the components of the workpiece and by the strength requirements that must be met for the individual welds themselves.

During welding, the tungsten electrode does not come into contact with the workpiece ; the arc is initiated by a high-frequency discharge across a predetermined gap, between the electrode and the workpiece.

Advantages claimed for puddle welding compared with more conventional methods are :

Ability to weld on assemblies where access for the torch is restricted to one side of the work ;

Close control over penetration to give good external finish ;

That equipment can be made self-contained and mobile and can be readily adapted to work on assemblies of varying size and complexity ;

And that capital cost of equipment is comparatively low—welding-guns can be made portable and simple.

Efficient structures place a premium upon high-performance fasteners for detachable panels and cowlings, and Unbrako, Ltd. exhibited examples of the Milson fastener that is used in large numbers on supersonic airframes. The virtue of this fastener, apart from its ability to carry loads with high reliability, is that it will pull a panel into place despite as much as 0·006in misalignment. The construction is apparent in the accompanying illustration ; shear forces are carried by the large internally-threaded pin, which is reduced in diameter at the end to allow it to enter the female part of the fastener despite misalignment. The female part contains within it a loosely anchored threaded bolt, on to which the shouldered pin is screwed, drawing the panel into place. A two-start thread is used, so that only four turns are necessary to secure the fastener, and self-locking is effected by deforming the last few turns of the female thread. It will be noticed that the pin is retained in the panel only by the encircling wire spring in the shallow counter-bore in the inner surface, so that it can easily be replaced if, for instance, the self-locking device becomes slack. The projection within the inner skin of the female element is of course reduced in depth as the thickness of the skin increases.

Even in supersonic airframes metal cannot, of course, be used throughout, and there appeared on the stand of Marston Excelsior, Ltd., a subsidiary company of Imperial Chemical Industries, Ltd., a small section of a plastics radome constructed on a method which allows the surface to be heated for anti-icing or, conceptually, cooled as a protection from kinetic heating.

Anti-icing is achieved by ducting hot air through a system of channels between the inner and outer reinforced glass fibre skins. The channels, which are of triangular shape, are formed in the expanded rubber core and are lined with a thin glass-cloth laminate to provide additional strength. A special pattern, seen in the diagram, permits the use of channels of constant cross section, which is important for achieving adequate mechanical strength over the entire surface of a radome.

Before adopting the present patented construction, consideration was given to other means of providing a heated surface. The incorporation of electrical elements or grids in the structure was discarded for reasons of electrical performance. The use of a liquid heating medium had attractions from a heat transfer point of view, but has not been adopted owing to the difficulty of finding a liquid both chemically inert and having a similar dielectric constant to the radome structure.

Equipment and Processes

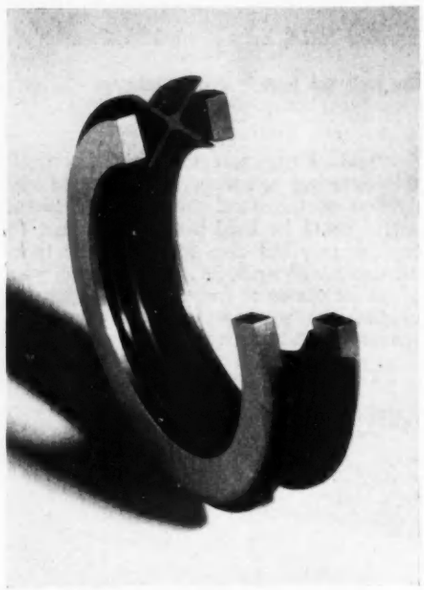
An extraordinarily practical realisation of the little-used phenomenon of electro-luminescence was displayed on the stand of Napier Aero Engines, Ltd. D. Napier and Son, Ltd., is the licensee in this country for the Sierracin Corporation, who make transparencies in glass, plastics, and stretched plastics, and apply to the transparencies Sierracote, a transparent coating of controllable electrical resistance. (Another demonstration on the stand showed that "Sierracote" could be used not only to heat the transparency but also to reduce the transmission of infra-red, i.e. heat, although when a double thickness for extra protection was applied the window was becoming semi-reflective). A transparency with a conducting surface is the essential basis of an electro-luminiscent lamp, and the Corporation have developed a number of different forms of lamp under the name "Sierraglo." The main product is a replacement for the present edge-lighted instrument panel in which the multiplicity of separate small filament lights is eliminated. The colour of light provided is red, obtained by using a yellow phosphor and a red plastic for the panel, since red phosphors are inefficient and even toxic. Lettering can be applied to the face of the panel by various processes, the instrument seen in our illustration having transparent

Fire seals for leading services unbroken through a firewall

Tool for embossing characters on metal or, as seen here, coloured plastics tape, on which the impressions appear white

white characters photo-etched by the U.S. Radium " Lackon " process. Such plastics panels are available up to 6in by 10in, although larger sizes can be made if a demand develops, and can be cut and drilled as readily as the basic plastic ; after cutting the edges must be sealed again, when the panel is highly resistant to humidity. The red lamps are not available for less than 300V a.c., but other colours, particularly green for electronic displays, can run at 115V. The photograph shows that one simple dipole connection to a panel is all that is needed. One of the significant advantages of such a panel is that it is not susceptible to sudden failure ; its brightness declines more and more slowly over a life of the order of 10^3 hours—the life is shortened by operation at higher frequencies such as 400 c/s.

A radically different form of lamp can also be seen in our illustration. This is a flexible strip of thin plastic, which can be cut (whether or not it is energised) with scissors. Such a light can be applied with great facility to existing equipment, and would appear to be a particularly convenient source of light without heat. It also enables the needle as well as the dial of an instrument to be illuminated ; the needle can carry a strip of thin film, and sufficient current to energise it be transmitted by a coil surrounding the spindle.



All-metal seal with loading rings to effect static or dynamic sealing against the cylindrical faces

There was shown by Palmer Aero Products, Ltd., a recently developed convoluted pipe of polytetrafluoroethylene, known as " Penflex " Due to its composition it is stable from —70 deg. to over 200 deg. Cent, and has an indefinite shelf life, while the convoluted form renders it flexible and resistant to kinking, so that it can be used for supplying breathing apparatus. When used as a conduit for (low-tension) electrical cables, it has the additional advantage that it can be compressed axially to give easy access to the backs of terminal fittings. The illustration shows " Penflex " and the appropriate fittings to match the new Hellermann " Bambi " miniature connector. Another new item on the Hellermann stand was a fire seal for leading cables through fireproof bulkheads ; each seal contains two discs of " Regalox " ceramic and, compressed between them, one of silicone rubber, each with a pattern of holes to fit the leads passing through the seal.

On the same stand was demonstrated the " Dymo-Mite " hand tool for embossing tape with letters and figures ; this product, is of United States origin, but has Air Ministry reference numbers. The tapes available include a wide range of coloured plastics, which when stretched by the embossing tool give white characters, and also metals, of which zinc and aluminium are available bearing, like the plastic, a contact adhesive. These tools are available to print either along, as seen in our illustration, or down the length of the tape.

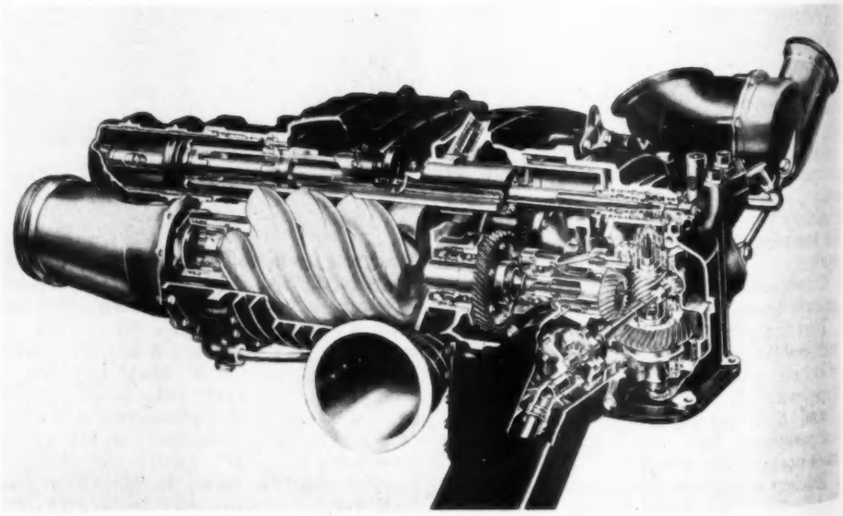
On the stand of Aero Controls, Ltd., there was presented the " Bar-X- " seal of the E. B. Wiggins Oil Tool Company, Inc., for which the simple claim is made that if metal will hold it, " Bar-X- " will seal it. The seal is circular and of *X* section, so disposed as to define an annular space ; there are two forms, one to seal upon the curved surfaces, as for a piston in a cylinder or a shaft in a gland, in which case loading rings are used (see accompanying illustration) and the other sealing upon the plane faces, in which case the seal is in one piece. The range of temperatures and pressures acceptable is wide : —425 deg. to 1200 deg. Fah. and up to 6000 lb per square inch. A particular virtue claimed is that the high pressure exerted by the sealing edges renders it unnecessary to super-finish the mating face, and indeed that it is self-cleaning and seals better as it polishes the mating member. In contrast to elastomeric seals, the " Bar-X-" will resist radiation, cannot contaminate the fluid retained, is not susceptible to catastrophic failure, and will even support side loads. A special advantage in control systems is that it is possible, with rod and piston seals, to adjust the friction introduced by the seal. Seals are available in numerous metals, including stainless steel and " Inconel " X, and plated with such finishes as tungsten carbide. The sizes available range upward from $\frac{1}{4}$in i.d. ; when sealing on the curved surfaces, the inner and outer diameters must be held within 0·005in and, if relative motion is to take place, the moving element must be circular within 0·00025in.

A number of the exhibits were concerned with ground effect machines, and one such was a fan shown on the stand of the Dowty Group, Ltd. A fan for such an application needs a favourable head/flow characteristic—the flow may go to zero when the craft is supported by the ground—and hence centrifugal designs are favoured, although variable pitch axial fans have also been built. The fan illustrated is structurally a tangent-spoked wire wheel, the two faces of the rim being separated by struts through each blade. It is claimed that efficiencies of 80 per cent are achieved with such fans ; our illustration shows an example 5ft 6in in diameter running at 870 r.p.m. and developing $\frac{1}{2}$ lb per square inch.

For handling air at the opposite extreme of pressure ratio, Sir George Godfrey and

A lightweight centrifugal fan for ground effect machines that is built in the manner of a wire wheel

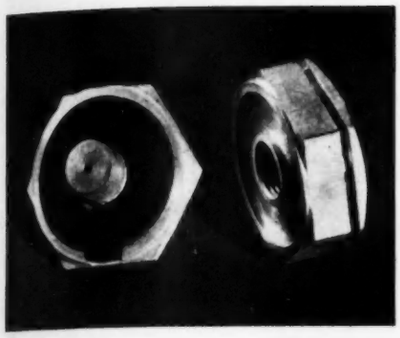
Partners manufacture positive displacement compressors under licence from Svenska Rotor Maschinen. To meet the needs of the cabin conditioning system of the Vickers VC-10 without resort to controllable drives, a Godfrey-S.R.M. compressor has been endowed with a slide valve varying the effective length, and hence the compression ratio, of the meshing rotors (see page 940, December 2, 1960). Since the demand for low pressure ratio is coincident with that for low throughput—full engine speed being used only at take-off—the valve is placed at the input end, and the input ends of the rotors act as crude centrifugal impellers forcing air out of the side valve to a dump separate from the intake. The servo system moving



Sectioned view of Godfrey-S.R.M. compressor with spill valve to reduce the effective length of the rotors

the valve is hydraulic, the compressor having its own force feed lubrication system (although a high-pressure supply is needed specially for the servo) and is interesting in using a fixed piston in a moving cylinder. The details of the construction can be seen in our sectioned illustration ; the slide valve is balanced by imposing delivery pressure on the end of the moving cylinder so that hydraulic failure causes the valve to open and reduce to a minimum the air delivery.

Wilmot, Mansour and Co., Ltd., showed a vent designed to protect a sealed container from pressure differences without employing moving parts while holding to a minimum the



Vent plug with long, restricted passage inhibiting diffusion of water vapour

diffusion of water vapour. The vent, which is simply screwed together through a plain hole in a sheet, has a rubber sealing disc into the face of which is moulded a long passage, as can be seen in our illustration. The size of the vent necessary is dictated by the most rapid note of change of pressure which may be encountered, and at the corresponding high flow rates through the vent the pressure loss arises mainly at the end of the vent and is not distributed along the narrow passage ; thus the cross section of the passage need not be much larger than that of a mere hole, and so the rate of diffusion of vapour through the vent is much diminished.

Gloucestershire Section of London–South Wales Motorway

PROPOSALS to establish the route of 11½ miles of the London–South Wales motorway in Gloucestershire have been published by the Ministry of Transport. This section will link the Severn Bridge scheme, now under construction, with A46 near Tormarton. It is planned for completion at the same time as the Severn Bridge, i.e. in 1965–66. Two spurs included in the project, at Almondsbury and Hambrook, will eventually form part of the proposed Birmingham–Bristol Motorway (M5). Junctions will also be provided with the Bath–Lincoln Road (A46) and with Filton Lane. Construction of the new motorway will require twenty-seven bridges.

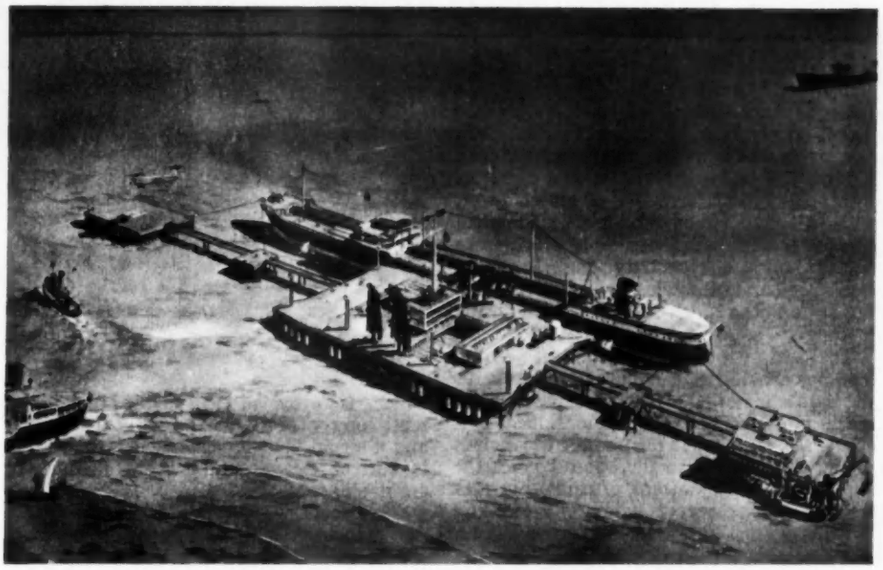
An important feature of the project will be a large motorway junction near Almondsbury, giving interchange facilities between the London–South Wales and the Birmingham–Bristol Motorways. This will be the first major motorway interchange to be built in this country. Details of the design of this junction, which will be of considerable size and complexity, will be published later, the Ministry states.

The proposed line of route from Almondsbury to Tormarton has been surveyed by the Gloucestershire County Council and from Almondsbury to the Filton by-pass by Messrs. Freeman, Fox and Partners, consulting engineers, who are also designing the motorway junction at Almondsbury. Objections may be made to the Minister during the next three months.

Tanker Loading Booms with Automatic Luffing

Super-tankers are too large to be accommodated up river at Fao, in the Arabian Gulf, and a loading terminal has been constructed for the Basrah Petroleum Company, Ltd., in some 70ft of water at Khor-al-Amaya, about 20 miles off shore. The oil loading equipment has had to be specially designed to suit conditions at the terminal.

THE terminal is a piled structure with an overall length of about 1300ft and consists of a central main island from which all loading operations are conducted and two smaller islands, one opposite each end of the main island and connected to it by bridges. One of the smaller islands is designed for helicopter landing ; the other has a crane for unloading stores from a tender. The centre island is a little over 400ft long and 230ft wide, and can deal with two tankers simultaneously, one on each side. A loading capacity of not less than 7000 tons an hour at each berth was specified, and it was also a requirement that whatever form the loading gear took it should be designed to operate with the minimum possible manpower. Because of the exposed situation of the terminal special problems arose as a result of weather conditions. It was necessary to design loading equipment which would not only deal with the normal change in relative height between the ship and the jetty because of tides and increase in draught as loading proceeds ; the equipment has also to allow for movements of the ship caused by waves.



Artist's impression of deep water tanker terminal now nearing completion in the Arabian Gulf

Four loading units have been designed by the consulting engineers, Rendell, Palmer and Tritton, and built by Woodfield Rochester, Ltd., Frindsbury Works, Rochester. They are located on the main island, two for each berth and all of them can be operated from either deck level or from a single control tower which affords a clear view for manipulation while the equipment is connected to the ship. Each of the units is equipped with automatic luffing gear which responds to ship movement caused by tide, draught increase or weather, and allows the equipment to be left unattended during the loading period.

Each loading unit comprises a counterbalanced boom of welded tubular construction pivoted on a tubular column, the foot of which is bolted to the structure of the island. There is a ball bearing slew ring at the upper end of the column, and the boom can be luffed within the range 70 deg. above to 40 deg. below horizontal, and slewed 55 deg. either side of centre. Counterbalancing causes the boom to maintain a positive upward load at the outer end under all conditions, and luffing is by means of a wire line anchored to the island deck through a return block. A five-drum electro-hydraulic winch is housed in the tail of the boom (where it also serves as a counter-weight) and this winch provides the power for the primary and secondary hose lines and the luffing or deck line. Each hoisting drum is driven by enclosed chains and epicyclic gearing, with post-type brakes and clutches actuated by hydraulic cylinders and solenoid valves with remote control. " Over "- and " under "- wind limit switches are fitted to all the hoist motions. For slewing there is a separate electro-hydraulic mechanism mounted on a platform on the main column and driving through reduction gearing and pinion to a spur gear on the column. Limit switches are fitted in both directions of travel. All the hoisting motions and the slewing have infinitely-variable speed control.

The main crude-oil transfer pipes consist of a 20in diameter riser within the main column, bifurcating into two 14in diameter pipes forming the outer lower members of the boom and converging at the boom head through swivel elbows, from which the 12in diameter smooth bore loading hoses are suspended. These hoses are each 45ft long, and terminate in swivel joints and elbows for

connection to the tanker manifold. Two stainless steel bellows joints are fitted in the 20in riser to allow for thermal expansion, and ball bearing swivel joints permit the luff and slew motions of the main boom. Provision is made for easy replacement of the swivel seals, luffing eyes being provided to raise the main bifurcating tee piece at the luff trunnions for this purpose.

The loading units are arranged to operate in pairs from a common control point 40ft above island deck level, and duplicate controls are provided at deck level near the foot of the main columns. Electrical controls in each console comprise selector switches for each winch drum, joystick controls for winch and slew motions, selector switch with positions for "manual," "off" and "automatic" operation, and lights to indicate the winch or drum selected, limits tripped, supply on, motor overload and other operating details. All the electrical equipment is Buxton certified for use with Group 2 gases, the main wiring being in mineral-insulated cable.

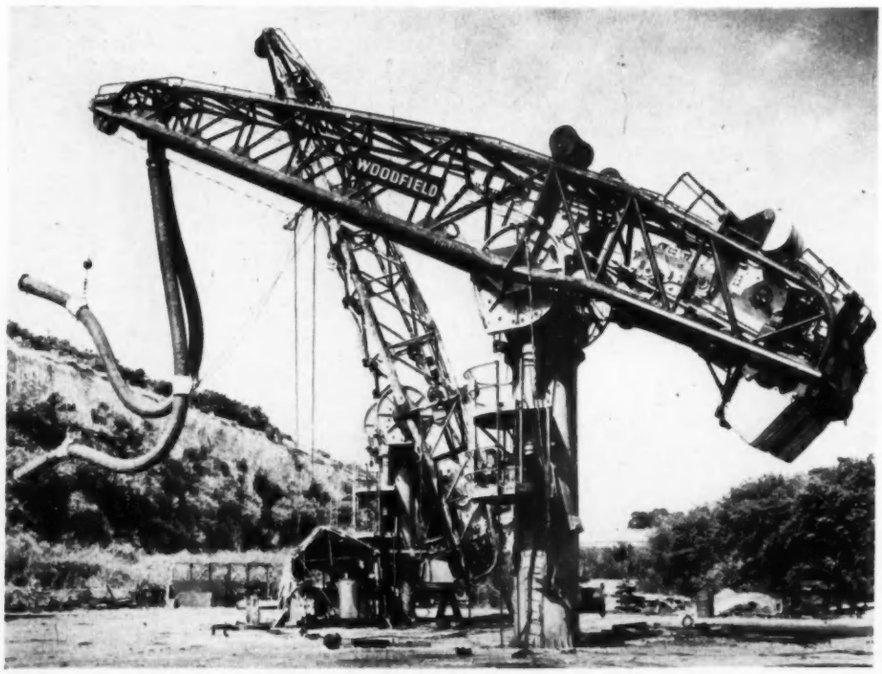
Two pre-fabricated houses at deck level contain the main switch gear and also the controls for flameproof lighting throughout the equipment. The booms are designed to make connections to tanker manifolds in any position from 37ft above island deck level to 18ft below it, at horizontal distances from manifold to berth face ranging between 9ft and 30ft. After coupling under manual control the primary hose lines are disconnected and the secondary hose lines are free-wheeled, so allowing the hoses to take up an uninterrupted natural curve during loading.

To deal with ship movement during loading, a nylon signal line is connected to the ship's manifold. This line passes over the head of the boom and is tensioned by a spring reel mounted in the boom. Movement of the ship relative to the boom rotates the spring reel and, by means of cams, operates a series of flameproof switches controlling the luffing gear. By means of this mechanism the boom is luffed automatically at every 6ft rise or fall of the tanker. An electric winch is provided to enable the initial tensioning of the line to be carried out, and a signal light indicates when the setting is correct for switching from manual to automatic control.

Comprehensive safety devices are incorporated in the equipment, which is designed for a normal operational wind load of 7½ lb. per square feet. Special locks are provided between the boom heel and the main column to withstand a wind force of up to 120m.p.h. These storm locks are electrically interlocked to immobilise all motions while the boom is locked.

Two hydraulic snubber cylinders are provided to control the movement of the boom in case of failure of the deck line which actuates the luffing. Failure of the deck line immediately releases a hydraulic stop valve, so locking the boom in position. A hand control valve with three positions permits either normal operation or automatic hydraulic lock, or, in the third position, release of the snubber fluid to allow the boom to return to its normal rest position (nose up) at a safe speed. A hand-operated hydraulic pump connected to the snubber system can be used to lower the boom in case of emergency, and so allow the hoses to be uncoupled from a tanker.

Two of the booms under test at the maker's works. They are shown here in the "rest" position



The nearer of the two booms has been luffed to the working position

DURGAPUR STEELWORKS.—A large scale-model showing the areas of the Durgapur Steelworks for which Davy and United Engineering Company, Ltd., has been responsible, was shown to an invited audience in London last week, prior to its despatch to the Indian Industries Fair. Davy and United Engineering Company, Ltd., is a member of ISCON, The Indian Steelworks Construction Company, the consortium of thirteen British firms, which contracted with the Government of India to build an integrated steelworks at Durgapur, a small village in West Bengal. The value of the contract was £105 million, approximately half of which was to be spent on work in India, whilst the remainder was to be used for equipment from the United Kingdom. Initial output of the plant was planned to be 1,000,000 ingot tons per annum, but the layout of the works has been so arranged as to enable the various production departments to be expanded to achieve an output of at least 2,500,000 ingot tons. ISCON has announced this week that the continuous merchant mill, the fifth and last unit of the rolling mills plant, has undergone successful commissioning trials in the rolling of merchant bars. Tonnages from the mill are increasing steadily, Iscon adds, the best daily output reached to date being 251 tons.

British Association at Norwich

By Our Own Representative

USUALLY at the Annual Meeting of the British Association for the Advancement of Science which is invariably held at this time of year there are to be found a number of themes connecting together lectures and papers presented before the different Sections. Some subject for a paper before Section A (Physics) will, for example, be found to complement that of a paper before Section G (Engineering) and will re-appear, to be seen in quite a different light, in, say, Section N (Sociology) or any of the intervening sections. It may turn up again in a discussion before Section X, a Section intended especially for people who are not scientists but who are interested in what scientists are doing. Again at the time of the Annual Meeting a number of special lectures, the Kelvin, Lister and Darwin lectures, are delivered. The theme may turn up in one or other of these or in one of the two " Evening Discourses " which are usually delivered during the meeting.

The trouble, of course, is that each morning of the meeting each Section holds its own meetings concurrently with the similar meetings of the other fourteen Sections. As often as not papers bearing upon a particular theme are being read in two or three different places simultaneously. Alternatively, the first part of the morning having been spent, say, with Section G a transfer has then to be made to a different hall or lecture theatre so as to learn what is being said in, say, Section A. Sometimes when the city in which the annual meeting is being held is not very well supplied with lecture theatres the various sectional meetings may be spread over quite a wide area so that transfer becomes hardly possible. But this year when the meeting was held at Norwich from August 30 to September 6 that problem was not acute. All but two of the Sections held their meetings in the City College, Lakenham School and Hewett School all within a couple of hundred yards of one another and all very modern architecturally and the other two were accommodated at Tuckswood School not very much further away. Nevertheless any single individual cannot hope to present an exhaustive report of everything said which should be of interest to engineers. Much must depend upon which sectional meeting he happened to attend and for the present writer's part, in accordance with views expressed in a leading article in this issue, he regards an Annual Meeting of the B.A. as an opportunity to hear what is being done in other scientific fields as much as in engineering so that he did not listen to everything that happened in Section G. However some aid is given because the Association makes available to the Press summaries of most of the papers presented.

Often the theme or themes running through a B.A. meeting have either no relevance at all to engineering or only limited relevance to it. More often, perhaps, the main relevance lies with some other Sections though engineers will certainly feel that they want to know something of the subject so that they may apply the findings. This year—rather unusually—two of the main themes had their roots as much in engineering as anywhere else. The first related to farm organisation and management and the mechanisation of agriculture ; the second, inter-related to some extent with the first and drawing its inspiration from the geography of Norfolk, related to land drainage, water supply and kindred subjects. A third theme, to which less attention will be devoted, had overtones of interest for engineers. It had as a link connecting the papers together the subject of spectroscopy. For the rest there were a number of disconnected contributions.

Agriculture

Section M is the Section concerned with agriculture. Fittingly therefore we may begin by quoting some sentences from the Presidential Address to this Section by Sir William Slater. He already sees the future to lie with farms run, not as a way of individual life, but as large scale businesses. " For British agriculture to be on safe and solid ground . . . farming groups must be of a size which will permit the most effective use to be made of the available capital and allow economic mechanisation. They must have at their head men who are able to understand and interpret in practice the findings of the laboratory ; who understand modern methods of management ; who can apply scientific methods to save labour ; who can keep and use cost accounts in the organisation of the business ; and who have the time to think, read and direct . . . Farming is no longer an art or a way of life, but a highly scientific business and as such it calls for highly scientific management . . . The pattern must ultimately be that of all successful industries in which a chief executive or group of executives is responsible for the running of the business with a highly trained technical staff . . . Within the company there would be opportunity at the different levels for specialisation in branches such as mechanisation, stock management, or the use of fertilisers and agricultural chemicals." No doubt such ideas will prove anathema to the majority of small farmers. But they may appeal to young men without capital who are interested in agriculture.

The kind of thing that can be done by using scientific methods of development and combining them with engineering advances was shown in a Section M paper " Developmental Research in Agriculture " by A. C. Owers. When the beet sugar crop was first introduced into this country it was treated exactly like the mangels and swedes it displaced and all the spring work of cleaning and thinning was done by hand labour. Sowing was done at 16 lb of seed per acre. By contrast recent work has shown that using " monogerm " seed and mechanical drilling to give a 4in spacing between seed there can be a population of 30,000 plants per acre with a seed rate as low as 1 lb per acre and with no need at all for hand thinning or singling! The same kind of practice is revealed when dairy farming and sheep farming are studied. A paper by J. E. Jones " Future Developments in Farm Organisation " instanced one-man units of sixty cows as being established and successfully operated as a consequence, of course, of the use of forage harvesters, self-feed silage methods and milking machines in advanced milking parlour arrangements ; and envisaged the development of specialist sheep-farms operating on an equally intensive basis to dairy farming with one man responsible for 1500–2000 ewe flocks.

A number of Section M papers were read in joint session with Section G (Engineering). Mr. Claude Culpin reviewed achievements in mechanising agriculture and showed that certain trends exist such as that towards detailed improvements of tractors by providing hydraulic controls, low powered hydraulic drives and air conditioned cabs. It surely is rather surprising (considering that drivers of almost every other kind of vehicle are now protected from the weather) that so few tractors are equipped with cabs! Mr. Culpin also saw great scope for mechanisation and automation of work about farm buildings. Here again engineers cannot help feeling rather surprised that relatively little attention has been given to this aspect of farming.

But, perhaps, a more exciting paper for engineers was that presented by Mr. K. E. Morgan on " Future Developments in Automation on the Farm." To quote from the summary of this paper " The first step to forward automation on the farm is to provide a comprehensive system of instrumentation. Far too much judgment and guesswork persist in practical farming, and it is most desirable that we should provide farmers with the means of measuring accurately the processes they control. Once we can measure a process, we can probably produce automatic control devices. These will relieve the farmers of some of their routine control operations, thus freeing them to concentrate on overall control and managerial matters. However, even given adequate instruments and control systems, the automation of agriculture is difficult, and it is harder to justify automation in agriculture than in industry.

" Therefore it is desirable that any automatic equipments introduced into agriculture should be versatile and should be in quantity production. One starting point appears to be the farm tractor, which is versatile and which is in quantity production. The first stage in automating a farm tractor is to provide it with a reliable guidance system, and to this end workers in various countries have produced or are developing several different guidance systems. When some satisfactory system has evolved, the next step would appear to be to build into the tractor the capacity to make decisions. This might be done by analysing the decisions that a farmer makes—breaking down complex decisions into a series of sub-decisions if necessary—and then calibrating the tractor so that it reacts to a situation in the same way as an intelligent human would react to that situation. The degree of " intelligence " that can be built into a tractor is likely to be limited, but there are signs that an automatic tractor of this type could be built and could be advantageously used in farming. However, time alone will prove whether agriculture, with its variety of environmental conditions, raw materials and finished products, its dependence on almost uncontrollable input of sunlight, rain, genes and bacteria, can be automated."

One gets a mental picture of the farmer coming down from his room to eat a leisurely breakfast at 10 a.m. pausing on his way to press a few buttons ; of the " tractor garage " doors opening ; of a " team " of tractors emerging, each picking up automatically from a store the implements it will need for the day's work and all trooping off driverless to the fields and yards. Paper work would, no doubt, engage the farmer for the rest of the morning. During the afternoon, more to raise an appetite for his dinner than for any real need, he would take a stroll to watch the tractors at work. No doubt in the evening when they return, automatically, to the " garage " they will deliver up to him detailed typescript reports in triplicate of the work they have done mentioning also, no doubt, any maintenance they may need!

Mr. H. J. Nation presented a paper on

" Hydraulic Transmissions in Agriculture." Experimental hydraulic tractors have been under examination at the National Institute of Agricultural Engineering and by manufacturers for some years. There are, of course, technical difficulties. Transmission efficiencies, for example, are substantially lower than with gears and much of the loss turns up as heat in the hydraulic fluid. This defect can be overcome in several ways. It is, for example, desirable not to have to use a pump with a maximum rating several times that of the engine in order to obtain the necessary speed range over which maximum engine power may be employed. But the advantages in flexibility are substantial and it is contended that the major technical problems have been solved. The very real existing difficulty is that the first cost of hydraulic tractors would be high. But there is hope that the development of uses for the pumps and motors in other industries may bring about reductions in costs as increased production usually does.

There was also a paper before Section N (Sociology) " Sociological Factors Affecting Agricultural Progress " by Gwyn E. Jones. But the writer hopes its author will excuse him for thinking it did not reveal much that was not pretty obvious. To quote from the summary. " The most important group of factors which affect the adoption of new farming practices is economic. Labour shortage, or the need to increase output or to reduce costs form strong incentives to adopt new techniques. Further, the larger the farm business the greater is the likelihood that farming innovations are adopted ; the lack of adequate resources or a low turnover deters adoption. A farmer's acceptance of innovations is also hindered by the uncertainty which is inevitably associated with using new techniques, and by the further adjustments which may be necessary to the farm organisation as a result of adopting a particular innovation . . . The resistance to change methods and practices increases with age, so that young farmers generally adopt more innovations than their older colleagues. In addition, young farmers are generally better educated than the older generation. In the East Midlands, where a much wider range of educational background exists than among mid-Cardiganshire farmers, a high level of general education is associated with the adoption of a large proportion of farming innovations . . . A farmer's social relationships also affect his propensity to adopt modern farming methods."

Is not all this rather small beer?

Land Drainage

The county of Norfolk provides an unusually wide variety of scenery. Woodland and heath to the west, the low lying " Broads " over on the east, hilly country to the north north around Cromer, salt marshes in the neighbourhood of Wells (the Blakeney birdwatching centre is hereabouts) and, in the hinterland of Kings Lynn, at the outfall of the Great Ouse to the Wash, fenlands. Drainage and sea-defence problems become acute along parts of the eastern coast—Horsey mere which was inundated by the sea not so many years ago, at the time of a tidal surge in the North Sea, lies in this area—and in the fenlands. Interestingly a paper before Sections C (Geology) and H (Anthropology) indicates that the Fens were created less long ago than might be supposed. It was between 8000 B.C. and 4500 B.C. that the melting of glaciers caused a rise in sea-level (a rise which, much more slowly, continues to this day). By about 3500 B.C. the sea was " transgressing " on the land in Somerset, but in what were to become the fenlands the ground was still above sea-level and the landscape was dominated (of all things!) by fairly thick forests. The sea was transgressing, however, by 2500 B.C. For some reason the sea seems thereafter to have drawn back for a time, but the land remained low lying and badly drained. Somewhere around 100 B.C. to 100 A.D. the sea again began to transgress thus creating fens. The fenlands thus date back not much further than Roman times.

Much of the area of the Fens is comprised geologically of peat or of clay overlying peat. The effect of draining peat is to make it shrink, the consequence being a lowering of the land surface. Thus, as, historically, the fenlands have been progressively better drained first by windmill driven scoop wheels, then by steam-engine-driven pumps, followed by diesel-driven centrifugal pumps and nowadays by electric motors driving mixed flow and axial flow pumps the lift needed to raise water from drains into the rivers which discharge to the sea has increased. The largest pumping station in the Fens has a capacity of 3000 tons a minute against a head of 10ft. Two papers, one before Section E (Geography) and one before Section G (Engineering) by W. E. Doran and K. E. Cotton respectively dealt with drainage problems. The actual problem of lifting water from the land into the rivers has been long since solved though new ideas continue to be developed. Mr. Cotton, for example, described floating pumping stations consisting of cylindrical steel pontoons containing electrical pumping machinery linked to the shore of a drain by the discharge pipe which has two swivel joints so that the pontoon can rise and fall with the water level. The pumps are automatically switched on and off as the water level rises or falls. The advantages of such a station are that no piled structure is required as would be needed for a conventional pumping station ; and that it can be transported, if desired, to another site without difficulty.

The real problem of Fen drainage is less to get the water off the land and into the rivers than to get the water away to sea out of the rivers ; and to maintain the river banks at a high enough level, despite the continual shrinking of the peat. Mr. Doran's paper described the principles of the Great Ouse Flood Protection scheme which has already been fully described in pages of this journal. In brief a cut-off channel 27½ miles long is being constructed from the River Lark at Barton Mills near Mildenhall to Denver sluice. Its intention is to divert all upland flood waters out of the main channels of the River Ouse, direct to Denver sluice where a sea-level channel connects to the Wash. Relieved of 40 per cent of the flood discharge widened and deepened river channels should be able to cope with pumped discharges from the Fens themselves. A problem arises in raising river levels in that the addition of more material at the top of the bank may cause sinkage of the whole bank. One is reminded of the drunkard's progress ; two steps forward and three steps back! There is, too, the danger of causing slips to occur at the toe of the bank. This danger needs to be counteracted by creating a berm as the bank is raised. Banks are, of course, vulnerable to the activities of rats and moles (and latterly an even worse menace, the coypu). They make holes in them which, unless rapidly stopped up, leakage will quickly enlarge, endangering a whole section of embankment. Mr. Cotton showed himself strongly in favour of permitting grazing by small cattle or sheep, not only because river levels can cover substantial areas of ground which would otherwise be wasted, but because the hooves of cattle break down and stop up holes made by the rats, moles and coypu.

The Fens, and the low-lying country to the east of Norfolk, are in danger of flooding not only from extreme rainfall but by consequence of storm surges raising tidal levels in the North Sea. So it was appropriate that in Section A (Physics) there was a paper by G. W. Lennon upon such phenomena. In so far as the North Sea is concerned it brought out nothing very new as it has been known for many years that the occurrence of a surge can be forecast and even the heights of the surge can be foretold fairly closely. What is less well appreciated is that similar surges can occur on the western coasts of England. There owing to the highly indented coast line the forecasting techniques applicable to the North Sea have been found ineffective. Different techniques are being investigated.

In Section G (Engineering) there was also a symposium on the morning of September 5 on a subject that bears some, though only slight, relation to drainage, " Power Supplies and Water Resources." Two conclusions could be drawn from the five short papers presented.

One is that though the use of rivers for cooling water can cause harm to fish it seldom in fact does so for the simple reasons that for efficient condensation the temperature rise of the water is relatively small—less than 10 deg. Cent.—and that fish move away from the effluent if it is inimicable to them. In fact, for some species at certain times of year the conditions may prove the reverse of inimicable. Anglers are often observed to fish successfully below outlets from power stations. In fact, what happens is that immediately below the outlet the flora and fauna are not destroyed but altered.

The other is that it might be worth while in counting the cost of creating reservoirs for power generation, navigation, water supply, &c., to allow substantial sums for the recreational uses of such reservoirs. The paper by Professor Trembley in the symposium instanced a number of reservoirs in the U.S. where recreation value for boating, swimming, fishing, &c., exceeds that of the purpose for which it was created. Big Boulder dam on the Colorado, for example, is rated at 16,000,000 dollars per year production of hydro-electric power and Lake Meade, created by the dam is now producing 22,000,000 dollars in income annually from recreation.

Spectroscopy

A reference was made earlier to a theme at the meeting linked by the subject of spectroscopy. It was mainly confined to Section B (Chemistry) ; but the Kelvin lecture to Section A by Professor D. J. E. Ingram also dealt with it. Some of this material may have proved of interest to chemical engineers. The lecture, however, had more direct interest for engineers in general. The main theme of this lecture described how all the wartime research that was concentrated on radar and microwave electronics subsequently produced a new branch of research in pure science ; it opened a new " window " in the spectrum of the electromagnetic radiations which stretch from the very energetic γ-rays at one end to the long wavelength radio waves at the other. This, suggested the lecturer, was one of the most striking examples of how development in applied physics can sometimes initiate a major advance in fundamental research and thus reverse the normal trend in scientific development. Engineers are obviously more accustomed than physicists to finding that researches intended to solve some particular engineering problem lead on to the need

for fundamental investigations having at first no special target. Every engineering research laboratory must have experienced it and every director must have been troubled in mind whether or not to allow the fundamental research to be continued. That it can often lead back again to something particularly useful was demonstrated by Professor Ingram who instanced the " Maser " as an outcome of the research ; it uses the atoms themselves to produce microwave amplification and oscillation, rather than radio circuits or electron beams and is finding engineering applications.

More directly of interest to engineers was a paper by Dr. A. B. Callear about the study now going forward at Cambridge University of the reactions which occur during the explosive combustion of hydrocarbon oxygen mixtures. The reaction is indicated by an intense flash of ultraviolet light and photographs are taken of the absorption spectrum by the use of a second flash lamp having a duration of twenty-millionths of a second. The mechanism of anti-knock is being elucidated.

Bits and Pieces

So much for such themes as arose at the meeting and which proved of interest to engineers. The rest must be a somewhat scrappy and disconnected record.

First then Section G. There were four papers presented before this Section which were excellent surveys of their subjects, " Preserved Timber as a Material of Construction," by Wm. E. Bruce, " Foundation Design for Modern Buildings," by Thomas Whitaker, " Mechanisation of the Postal Services," by Brigadier K. S. Holmes, and " Stator Fed Variable Speed a.c. Motors," by J. C. H. Bone. Even an attempt to summarise would take up too much space. Additionally, there was a whole morning's symposium in conjunction with Section A (Physics) on " Unconventional Methods of Energy Conversion " which drew a very large audience. Professor Cowling first demonstrated that virtually all processes of generating electricity depend ultimately on solar energy or nuclear reactions and that the efficiency of these processes is very much lower than conventional estimates suggest. He demonstrated the point by considering how much of the energy from the sun absorbed into sea-water, which eventually fell as rain and passed through hydro-electric generators, eventually appeared as electric energy. He also pointed out the importance of availability. Hydro-electric energy can be made readily available in large quantities ; solar energy, directly, cannot. Mr. F. H. S. Brown carried the matter further. Confining himself to "available" processes he pointed to the fundamental limitation of efficiency shown by the formula $(Tt-T_2)/T_1$. By burning fuel in air temperatures around 1700 deg. Cent. can be reached. But they cannot be withstood by present commercial metals continuously so that such temperatures cannot be used in turbines or similar machines. They can be used in the internal combustion engine because the high temperature material is in contact with working material only intermittently. But the intermittency imposes a limit on the size and rating of such engines.

The tendency amongst those seeking to exploit unconventional methods is to think in terms of something which would operate at temperatures between 1700 deg. Cent. or more and the 600 deg. Cent. or so suitable for conventional machinery. Three methods of attacking the problem were discussed at the meeting. The first was the magneto-hydrodynamic cycle in which combustion air is preheated and compressed, has fuel burned in it, and is expanded to a high velocity and low pressure in a nozzle. The gas is passed through a magnetic field and thereby generates electric current between electrodes. It is necessary to have a sufficiently high electrical conductivity of the gas and this can be achieved by thermal ionisation of K or Cs atoms seeded into them. Unfortunately, there are a number of difficulties, not least of which is a need for a high temperature as well as a high velocity after expansion.

The second method is that of thermionic generation using diodes. There appears to be less practical difficulty here and small generators have immediate applications in space vehicles. Development into high power devices is a different matter, however. The third method is that of thermo-electric generation. A thermo-junction is used as the source of power. Unfortunately, the properties of materials available in practice contrast quite severely with ideal requirements.

Curiously enough the symposium included no paper on the fuel cell. But Section G put the record straight by including a paper on that subject in its programme for the final morning of the meeting. A fuel cell, of course, converts the chemical energy of a fuel directly into electricity. The hydrogen and oxygen fuel cell, at present more highly developed than any other, works of course, by the reversal of the process of electrolysis. According to Mr. K. R. Williams, author of the paper, practical fuel cells working at 70 to 80 per cent overall thermal efficiency have been constructed. However, before a practical unit generating substantial amounts of power can be evolved many engineering problems have to be solved. As Mr. Williams remarked " fuel cell research is not for the faint-hearted."

Outside Section G attention may be devoted to a paper before Section J (Psychology), a Presidential Address to Section F (Economics) and an Evening Discourse. Engineers are well aware of the difficulties roused by vibration in the operation of many devices. Operators of engineering devices face the further complication that vibration may make it difficult to read instruments. The reference here is not necessarily to the effect of the vibration on the instrument itself but to the relative movement between a human being on a vibrating platform and the instrument he is trying to observe. The Admiralty and the R.A.F. are conducting researches on this subject and a paper was presented to the meeting by Mr. D. H. Drazin. The conclusions reached are interesting. At frequencies below about 4 c/s the eye is strongly compelled to pursue its target, but does so with diminishing effect as frequency and amplitude are increased. Above this frequency, however, a reasonably steady impression of the dial can be obtained by fixating either nodal image. That this method of observation was found to be more effective at large amplitudes is attributed to the greater separation of the nodal images. In view of this result and the fact that the nodal images appear in diminished visual contrast, it is suggested that practical benefit would accrue from the use of transparent dial faces illuminated from behind and that the colour and brightness of instrument panels should be consistent with the background of the instrument dials themselves. It was also found that the legibility of a circular dial depended upon the actual dial setting ; appreciably greater accuracy was obtained when the pointer lay in the direction of vibration. It is suggested, therefore, that when the vibration pattern of a vehicle has a predominant directional component, circular dials should be replaced by linear instruments which are so oriented that the pointer and all scale marks lie in the direction of motion.

The Presidential Address to which reference was made above was that by Professor C. F. Carter on " The Economic Use of Brains." Professor Carter cast doubt on the rather commonly held assumption that there is an immense and untapped reservoir of " brains " which can be made available by extending education to people of all classes. " It does not seem unreasonable to suppose that among the attributes of outstanding ability is an unusual power to rise above the limitations of social class, and that the British educational system before the war may have been far more efficient at recognising and assisting the really able boy than it was at developing the best qualities of the mediocre." If this is so then the corollary is, to quote Sir Robert Wood (as Professor Carter did), " We are not going to get a great deal more first-rate intellectual butter, we are going to have to spread it over more bread and make do with a lot of margarine." It is out of that conception that there has grown the idea that an able man should never do work within the powers of those of less ability. But Professor Carter was at pains to reveal that there might well be a fallacy in that argument. We know too little about the complex nature of intellectual effort. It may be important to an able man to have an alteration of easy with much more difficult tasks. " A brilliant scientist does not want to spend his days sitting in a corner of his laboratory, engaged in pure thought, while his assistants perform the experiments under his direction. The grumbles about inadequate help from technicians can, in fact, be matched by complaints from technicians and industrial staff in laboratories that scientists insist on doing work which ought to be the responsibility of junior staff." Professor Carter also drew attention to the ways in which brilliant youngsters choose careers. He suggested that the choice is " necessarily ill-informed, both in regard to the potentialities of the boy or girl and in regard to the advantages and pleasures to be found in the occupations to which the specialisation will lead.

Lastly we come to the Evening Discourse. It was by Dr. B. V. Bowden, Principal of the Manchester College of Science and Technology, and was entitled " The Impact of Automation." The treatment, deceptively, was historic—deceptively because it led up to an unexpectedly passionate dénouement. Dr. Bowden pointed out that automation had been going on for hundreds of years and that in the eighteenth century Arkwright and others so automated industry that Britain led the world in textile, production and also in several other fields of human endeavour, including the production of machine tools. Other countries had to learn from Britain. But to-day the boot looked to being transferred to the other foot. For a century or more, Dr. Bowden declared, British technical education had been far less effective than elsewhere in the world and was still defective. As a consequence, Britain was falling behind in its ability to design advanced technological devices. The machine tools we imported cost about double as much per ton as the machine tools we exported, indicating that other countries were exporting brains to us. Amongst the advanced Western nations Britain had the fewest computers per head of any. Yet it was the computer which promised immense advances in automation. He feared, in fact, that Britain was falling back amongst the nations and might well become the Spain of the Twenty-first Century.

Human Translation and Translation by Machine

Among the papers presented at the recent International Conference on Machine Translation of Languages and Applied Language Analysis, held at the National Physical Laboratory, was a contribution from the University of Milan entitled "Human Translation and Translation by Machine." The authors were E. von Glasefield, Sergei Perschke and Elsa Samet. We present below some passages from their paper which illuminate the problems encountered in attempting the task of translating by machine.

THE assumption that words have meaning and that their meaning is determinate, relatively constant, and, therefore, also analysable, is indispensable for translation, because it is indispensable for every kind of linguistic activity—except perhaps that esoteric form of poetry that is intended to stimulate rather than to communicate. Wherever words are used for the purpose of communication they have to "convey" something from one person to another, and this something must not be changed by or during the process.

The relation between a word and the thing it "conveys" is the semantic relation which, under all circumstances, is established by agreement and mostly becomes a convention. Words give instructions concerning the operations that are required to reconstruct the particular things that constitute their meaning. Expressed in its simplest terms, verbal communication between *X* and *Y*, therefore, consists of the following steps :

(1) *X* carries out a sequence of operations which results in a certain thing *N* ;

(2) *X* presents to *Y* the word *W* which, owing to an established semantic relation, indicates the operational result *N* (*N* is the nominatum of *W*) ;

(3) *Y* carries out the operations indicated by the word *W* and thus reconstructs the result *N*.

If a thing *N* has been given a name, that is, if one has agreed to link it by means of a semantic relation to a word *W*, then *N* is the nominatum of *W*, and the question as to the meaning of *W* can, now, be put more explicitly, how does one have to operate in order to obtain the nominatum of *W* ? The analyses carried out by the Centro di Cibernetica in Italian, English, German, Russian, and other languages, have confirmed us in the conviction that the operations by means of which human beings construct the nominata of words are always of the same few kinds, regardless of the language that is to be used. These operations are : differentiation, figuration, categorisation, and correlation. The signification of a linguistic expression (word or sentence) is always made up of results of these four operations, taken singly or in combination, and we can draw up a general pattern for their possible distribution in the significations of linguistic expressions :

The signification of a single word may be :

(A) A single differentiatum, figure, or category (simple nominatum) ;

(B) A combination of these (composite nominatum) ;

(C) A correlation or a correlational net (i.e. a combination of nominata that may themselves be simple or composite) ;

The signification of a sentence is always :

(D) A correlation or a correlational net.

The vocabulary of a natural language, in fact, contains comparatively few words of type A ; that is, words whose signification, regardless of their occurrence in or out of context, is a single differentiatum, figure or category. The majority of words are of type B ; that is, words whose nominata are composites. They are no less definable, but necessarily as a combination of operational elements. And because their nominata are composites they sometimes function in different ways according to the context in which they occur. This does not mean that their nominata change—it only means that in certain contexts some of their elements are operative while others remain irrelevant for the overall signification of the expression.

The interplay of operational elements pertaining to different nominata is certainly one of the most complicated aspects of semantics. The detailed analyses that have to be carried out in order to establish something like a comprehensive pattern for a whole language are a matter, not of a few months, but of many years of co-ordinated team-work. The result of such an undertaking would be the first operational dictionary ; that is, a dictionary that does not—like the existing ones—define words by a circle of references including a greater or smaller number of other words, but by giving the actual operational composition of the respective nominata as well as the various functions its elements may perform in different contexts. At present we have only just begun to realise the vastness of the analytical work that has to be done before even a first tentative edition of an operational dictionary could appear.

That operational dictionaries of the input and output languages are an absolute necessity for mechanical translation has become clear in the course of the analyses we have recently carried out in various languages. We have found that the operations by means of which human beings construct the nominata of their words are always the same, but we have also found that it is rare for two words of different natural languages to have the same nominatum. Put in more generic terms, this means : the operations that supply the contents of the continuous, not yet articulated stream of thought are the same in every human being ; but its articulation (i.e. the way in which the operational results making up this stream of thought are then grouped in order to become the nominata of words) varies considerably from one natural language to another.

On the level of A (words with simple nominata) there are comparatively few discrepancies between natural languages ; where they occur, they spring from the fact that not all single results of differentiation, figuration, and categorisation that are individually designated by one language have been individually semanticised in all other languages. On the level of B (words with composite nominata) there are very many discrepancies ; they spring from the fact that the particular combination of operational elements forming the nominatum of a word of one language has not been semanticised in another language.

Considering the copious list of possible discrepancies between natural languages, one might be tempted to ask how anyone could ever produce something worthy of the name of translation. Indeed, if we maintained the notion that translation is the immediate substitution of words of one language for the words of another, we should have to conclude that translation is impossible. Yet, at this very moment, thousands of translators are busily working away, and what they produce is often perfectly satisfactory. How is this possible ?

The translator—like any receiver of a linguistic communication—reconstructs the original train of thought by obeying the semantic relations of the input text ; that is, by carrying out the operations that constitute the nominata of the input words ; and as he necessarily carries out these operations one by one, they also constitute a continuous stream of operating (namely the stream of thought *T*) whose operational elements can at once be re-grouped, or articulated, to form the nominata of another language. Thus a translator who is equally accustomed to articulating his trains of thought so as to form nominata of either one of two languages, may even remain quite unaware of the discrepancies between them, because he never steps directly from a nominatum of language 1 to a nominatum of language 2, but always and necessarily passes through the stage of continuous operating in which the first articulation is given up before the second is reached.

At this point it should be clear that neither words nor the often very complex operational constructs linked to them by a semantic relation can be taken as basic units in a translation procedure that is to yield results comparable to those produced by human translators. If, instead, the kind of operational analysis we suggested is carried far enough to isolate the very elements responsible for the discrepancies in the meaning of words we reach a level on which we can successfully avoid distortions of meaning in the translating procedure ; besides, the results of the analytical work we have to accomplish for one language with a view to translation into a particular other one will be applicable, immediately and without alteration, in the procedures of translation into all other languages.

However, even if we assume that the translating machine has been supplied with complete operational dictionaries for the languages it is to work in, its functioning still remains different, in at least one important respect, from that of a human translator. Given an operational dictionary, the translating machine can compile all the operational results indicated by a linguistic expression, but it cannot reconstruct the train of thought.

The technical difference between human and mechanical translators obliges us to make a further distinction between the processes of communication and translation. It is irrelevant whether words are considered to indicate the operational result *N* or the sequence of operations resulting in *N*, but this is true only for a process involving but one language. In this case the receiver of the communication can be expected to supplement as a matter of course (and mostly quite unconsciously) the operational indications of the

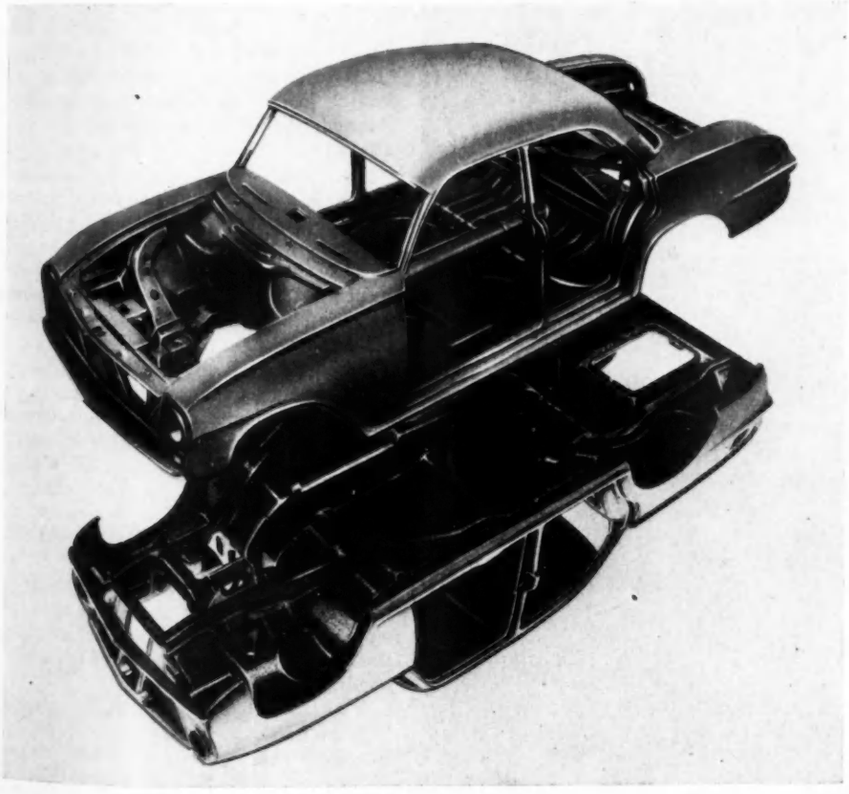
linguistic expression with those elements which the author—relying on a justifiedly presupposed similarity between the receiver's habitual ways of thinking and his own—has not bothered to include in his formulation. That is to say, while we stay within the realm of one language we can make use of a general fund of experience and knowledge common to all speakers of that language. In the case of translation, however, this is not necessarily so, because the common background knowledge (notional sphere) of one language group is by no means identical, or even equivalent, with that of another.

The human translator, being familiar with the notional spheres of both languages, has no difficulty in adjusting his output in such a way that it contains as explicit elements all those items which are notional matters of course in the language of the input but not in that of the output. But the machine can work exclusively with the operational elements explicitly indicated by the input text. Such elements as the human translator adds to the output on the strength of the general knowledge he possesses independently of and previous to any input would, therefore, be missing in the machine's output—unless we incorporate into the machine all these generally known and therefore not explicitly formulated elements by means of a network of classifications.

There will always be some cases, especially when translating from languages which in some respect are richer than others, where neither of our methods of analysis will enable the machine to reconstruct the original train of thought completely, for the simple reason that the output language has no means for the expression either explicit or implicit of certain operational elements expressed in the input text. But this should not be regarded as a shortcoming of the machine ; in these cases the human translator, too, is at a loss ; and it would hardly be fair, at this stage, to expect the machine to do better than we do.

Enlarged 1½ litre Car

THERE has been announced by Vauxhall Motors, Ltd., a redesigned version of the Vauxhall "Victor" with a significant increase in the internal dimensions, although the wheelbase and track have increased only 2in and 1in (½in at the front) from the former 98in by 50in, while the weight has been reduced by roughly 80 lb to bring all models below 1 ton kerb weight. The new body has been designed to reduce the cost of assembly by having only two-thirds as many separate pieces : for instance, the window frames are now integral with the doors. The necessarily increased cost of tooling for larger single parts has been held down by a careful choice of shape, but at the same time flat areas that might resonate audibly have been avoided. The body is made principally of sheet steel of nominal 19 g. (min. 21 g.), but the well for the spare wheel (the spare is stowed, erect in the fore-and-aft plane, behind the starboard rear wheel), which is visible from behind the car and is therefore not treated with under-sealer, is of galvanised steel. The paint treatment consists of phosphating, dipping in black primer up to but excluding the roof, spraying a primer surfacer all over the body, exterior and interior and also underneath all wing surfaces. A second coat of primer surfacer is applied to all upper exterior surfaces of the body. A $^{1}/_{10}$in coat of bitumen base anti-corrosion body deadener is also applied to all underneath areas of the body. The finish is two double coats of a new cellulose synthetic enamel : for this finish there is claimed a higher gloss and a lustre retention equal to that of "Lucite," acrylic finish used by the parent firm, while the hardness is also higher than the cellulose previously used. The primer dip process is closely controlled to obtain penetration of the paint, and when welded joints have been torn apart after dipping they have been found to be black except for the weld spots. The inner surfaces of the door sills are protected by spraying internally with aluminium-filled polythene wax.



"Mirror" view of a body shell, together with front wings, after dipping in black primer. Notice the large elliptical dishings strengthening the floor. The front suspension as well as the rear springs attach directly to the body by rubber bushes, and the sections supporting their locations can be seen

The shape of the envelope is one that is familiar and accepted abroad. A detail that contrasts with Vauxhall practice of the recent past is that the tail and side lights are well away from the corners of the car, and in fact the light fittings have been so disposed that from the side only the rear flasher lamps are visible. These lights and the horn(s) are protected by a thermal overload relay in the control switch : the AC-Delco windshield wiper motor incorporates its own thermal circuit breaker. A new feature is the use of toughened windshields which have an area in front of the driver which shatters less finely and thus remains relatively clear when the rest becomes opaque.

Perhaps the most distinctive feature of the new model is the choice of transmissions available. The final drive can be 39/10 (saloons only) or 33/8 (4·125) (a 37/8 (4·625) ratio is also available, particularly to suit adverse conditions in, for instance, Australia), with 13in wheels bearing 5·60, four-ply tyres on saloons and 5·90, six-ply tyres on the estate car, while the synchromesh gearbox can have either the normal three speeds with steering column control, or an optional four speeds with floor change. A high degree of similarity between these alternative assemblies is obtained, although the main casting of the box is longer on the four-speed version, by mounting the third (i.e. reverse) striking fork and rod on the detachable bottom of the box : the linkage for the floor change, although it is not a remote control in the sense of being mounted on the driver's side of the flexible power unit mountings, employs separate elements for movements across the "gate" and into and out of mesh. The clutch housing and gearbox rear extension are cast in aluminium.

Aluminium has also been adopted, to save weight, for certain parts of the engine, and to prolong exhaust valve life the valve faces are coated with pure aluminium, a treatment well established in the United States. The induction manifold, now aluminium, no longer has the thermal valve regulating the exhaust gas flow to the hot spot. The compression ratio has been increased from 7·8 to 8·1, increasing the peak gross brake mean effective pressure from 139 lb per square inch (at 2400 r.p.m.) to 141 lb per square inch (at 2200 r.p.m.) : the peak speed and torque thereat have also increased, from 4200 r.p.m. (54·8 gross b.h.p.) to 4600 r.p.m. (56·3 gross b.h.p.). A version of this engine giving significantly improved performance to a model termed the "VX Four-Ninety" is to be announced at the forthcoming Motor Show.

The most marked departure from previous practice in the new "Victor" is the reduction in the demand for routine maintenance : the number of nipples has dropped from nineteen to four. These four are on the ball joints of the front suspension, and require graphite grease every 12 months or 12,000 miles ; the estimated time for this work is five minutes. The engine oil change interval has been extended from 2000 to 3000 miles (or three months), and a 20W oil is recommended all the year round (between 10 deg. Fah. and 90 deg. Fah.).

Car Ferry "Camber Queen"

By G. W. TRIPP, O.B.E., F.C.G.I., M.I.C.E.

As indicated in a previous article* describing the car ferry "Fishbourne," a sister ship was due for delivery in August, and she is now in service, named "Camber Queen," the name being suggested by the City of Portsmouth. The vessel is constructed and equipped in all respects

*THE ENGINEER, July 21, 1961, page 101.

Fig. 1—M.V. " Camber Queen "—Portsmouth/Fishbourne, I.o.W. car ferry

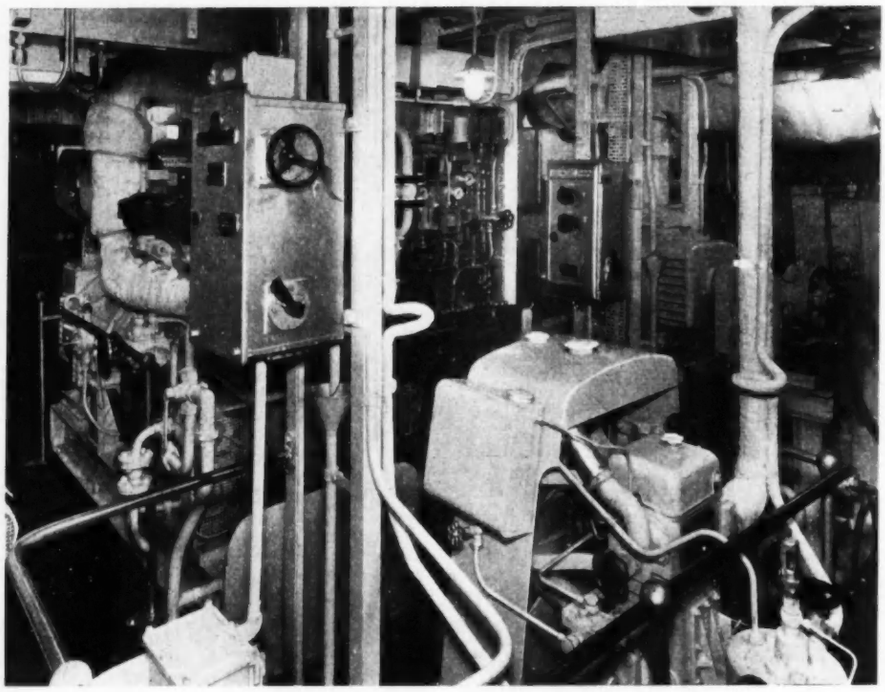


Fig. 2—Engine-room

Fig. 3—Car deck

to Ministry of Transport regulations for a Class IV ship. The hull is mainly of all-welded construction. She is designed to carry a wide range of traffic including cars, coaches, motor cycles, caravans, road tankers, agricultural machinery, etc. She was built by Philip and Sons, Ltd., of Dartmouth, her general appearance being shown by the illustration (Fig. 1).

Propulsion is by means of two Voith Schneider size 14E/90 cycloidal propellers, one at each end of the vessel. The arrangement is similar to that which has proved successful in M.V. " Lymington " and M.V. " Freshwater " operating between Lymington and Yarmouth, the forward propeller being fitted on the port side and aft propeller on the starboard side, controlled from the bridge, thus giving rapid and excellent manoeuvring, so necessary in confined tidal waters. The engine room (Fig 2) is well ventilated, and all controls readily accessible. The main deck is kept free for cars, &c. (Fig. 3) which can be driven on at one end and off at the other. A small upper deck adjacent to the bridge, is furnished with seats enabling passengers and car drivers to sit on deck for the passage, an amenity not provided on the older vessels.

Comfortable accommodation—often not found on vessels of this type—is provided, there being a lounge on the main deck, and a bar/buffet which seats 49 persons.

The " Camber Queen " and " Fishbourne " are a very definite improvement on their predecessors, and have reduced the passage time from approximately an hour to thirty-five minutes when conditions are favourable, while probably forty would be a safer figure, judging by personal experience, when opportunity was taken to cross in one direction by the older " Hilsea " and return on the new " Fishbourne."

As the main dimensions are similar to those of M.V. " Fishbourne " it is unnecessary to repeat them.

Letter to the Editor

ESSEX WATER SUPPLY

SIR,—I am surprised, in view of your own respect for the correct use of English, that you should reproduce, even as a verbatim quotation from someone else's Report, in your leading article of August 25—" neither of these expedients can be considered economically viable." What the writer of the quoted report means is " economically practicable " and it is a great pity that people will use words with which they have just a nodding acquaintance without ascertaining what they mean. The use of a wrong word in a document intended to be informative is as irritating to an engineer as is seeing someone using the wrong tool to do a job.

Viable is an adjective that can only be used to describe a set of conditions governing the continued existence of life in some form at some time. It cannot possibly be used to qualify an expedient which has little or nothing to do with such considerations, particularly when half a dozen precisely applicable adjectives exist from which to choose.

Engineers should be as careful in preserving the exact meanings of words they choose to employ as they are, or should be, in keeping their tools sharp and their machines in good condition.

R. DIGBY-SMITH, M.I.Mech.E.

London, W.1,
September 1, 1961.

(Viable : Capable of living ; able to maintain a separate existence.—Shorter Oxford English Dictionary.—ED. THE E.)

SHORTER REPORTS

Microwave Measurement Techniques

A CONFERENCE on Microwave Measurement Techniques was held last week by the Electronics and Communications Section of the Institution of Electrical Engineers in London. In his introductory lecture on September 6, Professor H. E. M. Barlow said that microwaves occupied a unique place in the spectrum because they were, as a rule, susceptible to electrical as distinct from optical treatment, whilst requiring techniques that differed completely from those at lower frequencies. Attention must be drawn to the use being made to-day of ferrite isolators, circulators and modulators in microwave measurements, resulting in a great improvement in the ease with which precise observations could be achieved. With the introduction of these devices it had been possible to vary the different parameters of a circuit without seriously disturbing either the frequency of the supply or the power levels which it was required to keep constant. In general, accuracies within $\pm 0{\cdot}1$ per cent were obtainable in measurements of impedance and reflection coefficient, with ± 1 per cent in measurements of power, whilst an attenuation could be established without difficulty to within $\pm 0{\cdot}01$ dB up to about 3 dB, or a noise level to within $\pm 0{\cdot}1$ dB.

Giving a broad classification of measurement techniques, Professor Barlow spoke first of those depending on arrangements for probing the electromagnetic field at various points and, with the help of a detector, observing relative amplitudes; or by comparison with a standardised source determining absolute values both in magnitude and phase. A directional coupler as a means of picking out and examining separately incident and reflected waves was clearly a valuable supplementary device in measurements of this kind, and combinations of such couplers formed the basis of the so-called " reflectometer " which had found further important applications recently.

Bridge circuits for comparison between an unknown impedance and a standard one might be used in conjunction with probe techniques. Multiple-arm waveguide junctions could be employed in much the same way as the Wheatstone bridge, but to be successful the microwave device must have a high degree of electrical symmetry. Recent work had enabled accurate bridge measurements of this kind to be developed.

Another class of measurements depended on resonance arrangements. Cavities or surface-wave resonators, each excited in its own particular wave mode, could conveniently provide a definite relationship between wavelength and frequency so that these quantities were available as measurements when an oscillator standardised from a quartz crystal or from a molecular spectral line was employed. Cavity resonators were also of great value in sample measurements of the electrical properties of materials. For attenuation and phase-shift measurements a new group of attentuators and phase-shifters making use of the special properties of ferrites and semiconductors had recently made their appearance. Some of these were not at present suitable as standards of measurement but they formed valuable ancilliary equipment. Deliberate generation of noise under controlled conditions of source temperature was important as a means of measuring noise inherent in any given circuit or equipment. In the microwave band noise generators were still undergoing development and their application to the kind of measurement for which they were so useful at the lower frequencies had yet to be fully established.

Continuing to discuss power measurements, the lecturer described the film bolometer developed by Lane and his colleagues at the Radio Research Station at Slough as perhaps one of the most versatile and successful instruments in the class of devices based on a comparison between the heating effects of a microwave and of a low-frequency current. Apart from calorimeters which absorbed all the power incident upon them, the thermistor and the bolometer were essentially devices operated by the electric field only, and consequently if they were to give a measure of true power, the load must be matched, with the eliminiation of all standing waves.

When one considered the known possibilities in devising instruments capable of operating from both electric and magnetic components of the field simultaneously, it appeared that the only two alternatives readily available were radiation pressure and the Hall effect. The former had been transformed into what was essentially an electrostatic voltmeter technique dependent for its operation on electric field alone, so that the instrument gave true power only under matched load conditions. The subsequent development of an arrangement employing two vanes separated from one another by a quarter of the guide wavelength offered the possibility of correcting for errors caused by reflections from the load.

The application of the Hall effect was attractive, but there were complications due to rectifier action and thermo-electric e.m.f. superimposed on the Hall effect. Considering, for example, a semiconducting crystal erected in an electromagnetic field, a thermo-electric effect was produced by the metal-to-semiconductor contacts at which the leads were attached to the crystal. If, however, the microwave was modulated at a frequency high enough to prevent the crystal temperature from following it, the observation of the audio-frequency voltage output would exclude any thermo-electric effect.

A second disturbing influence was rectifier action, also originating at the metal-to-semiconductor contacts. However, since the rectified voltage output depended only on the geometry and electrical properties of the contacts, this voltage could be distinguished from the Hall and thermo-electric effects by rotation of the crystal through 180 deg. about an axis aligned with the transverse component of the magnetic field. Such an incursion of the crystal caused the Hall e.m.f., together with any thermal e.m.f. present, to be reversed whilst the rectified output remained unchanged. If the crystal were rotated continuously at frequencies which the thermal e.m.f. could not follow, it would eliminate the need to modulate the power transmitted because the output at the rotation frequency would become a true Hall e.m.f.

Another proposal was to use a cascade assembly of Hall crystals to measure high power densities in free space. With a large number of crystals it was hoped to concel out very largely the unbalanced rectifier effects and at the same time to increase the output for a given power density.

Translation by Computer

DEMONSTRATIONS were given in London last week of a system which has been developed for enabling foreign texts to be translated on a general-purpose computer. The system is the work of Machine Translation, Inc., 821, Fifteenth Street, Washington, 5, D.C., and it employs a vocabulary based on the reduction of language and meaning problems to numerical form. The fourfold transfer process of translation (function, form, meaning and distribution) has been transformed into one process, called the " unified transfer system " (U.T.S.). In order to achieve this transfer, a classification system has been devised for each of the four transfers expressed in the form of an eight-digit code. The individual codes are incorporated into 479 master code patterns. Each code pattern determines all possible meaning, form, functional, and environmental conditions for a class of words. Therefore, each word in the dictionary will carry a pattern reference number and the dictionary operations are thereby greatly reduced. These master code patterns are stored as part of the programme. The smaller dictionary and increased speed of working obtained by this system allow economic use of computer time and are important factors in justifying the adoption of machine translation.

The demonstration took place at the premises of C.E.I.R.(U.K.), Ltd., 58-62, Newman Street, London, W.1, and consisted of the translation of parts of an article in *Pravda*, first from Russian into English, and then from Russian into German. The work was done on an I.B.M.7090 computer. At the moment a speed of 60,000 words per minute can be achieved, but this will be increased to 150,000 words a minute next year. The system will also be refined by addition of a syntax so that words are printed out in the English order instead of in the order of the Russian text as at present. Texts for translation are now put into punched card form on I.B.M. cards, and then transferred to magnetic tape for feeding into the computer. Simultaneously the Russian-English dictionary and the programme codes are fed in on other tapes. Among developments envisaged are the punching of a text for translation on to paper tape, and eventually optical scanning of the text.

[Reply Card No. 1174]

Fluorescent Lighting Fittings

FITTINGS in the " Durham " range announced by Ekco-Ensign Electric, Ltd., 45, Essex Street, Strand, London, W.C.2, incorporate a bi-pin lampholder which can be hinged back against a spring for inserting the fluorescent tube. Its depth is reduced compared with a fixed holder having internal spring plunger contacts, but when in the working position it completely encloses the end cap of the tube. It is stated that the improved contact pressure assists starting due to lower millivolt drop in the circuit. The " Durham " fittings are available for 4ft, 5ft and 8ft tubes in batten, enclosed diffuser and reflector patterns suitable for industrial and commercial installations. Batten and reflector fittings can be butted end to end for continuous lighting. All patterns are available for one or two tubes, and can be supplied with switch-start or transformer-start circuits.

[Reply Card No. 1173]

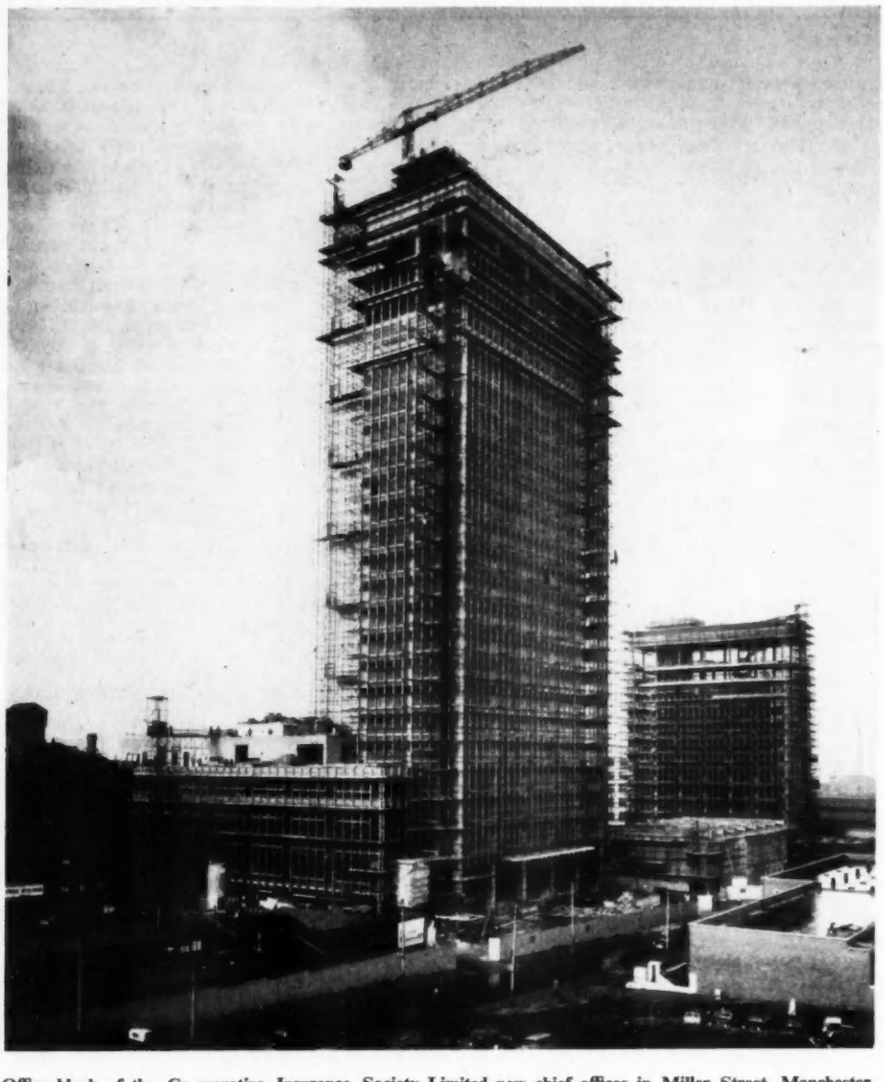
Structural Computation Service

IN addition to its service in testing structural models the Cement and Concrete Association states that it is now in a position to offer the use of an electronic computer. A Ferranti " Sirius " computer and tape editing equipment has been installed at its Research Station at Wexham Springs primarily for processing data for the Association's own research and advisory work, but also for hire. The Association states that it cannot provide a programming service, but its research staff may be able to advise on the preparation of programmes in connection with work involving the use of concrete.

Oil Production in Iran

THE Iranian Oil Exploration and Producing Company N.V. states that crude oil production in South Iran amounted to 4,953,000 tons in July and brought the total production for the year to 32,795,000 tons. Refinery throughput at Abadan by the Iranian Oil Refining Company, N.V. totalled 1,561,000 tons in July and totalled 8,010,000 tons in seven months. Drilling at the Exploration Company's exploration well at Bibi Hakimeh number 1 has been stopped at 6748ft although the well yielded 3500 barrels per day. Facilities for production testing are being installed but meanwhile the drill equipment is being moved to Kharg Island.

SHORTER REPORTS *(Continued)*



Office block of the Co-operative Insurance Society Limited new chief offices in Miller Street, Manchester. The building is 400ft high

"Topping Out" a Tall Building

A "TOPPING OUT" ceremony was held last Tuesday at the new office block of the Co-operative Insurance Society, Ltd., in Miller Street, Manchester. This building is 400ft high and is claimed to be the tallest building in Britain. It is of steel-framed construction, and the tower block will contain some 550,000 square feet, or over 12½ acres, of floor space, comprising twenty-five floors with a five-storey podium and three levels of basement. A contiguous reinforced concrete service tower, clad with Italian mosaic, rises to the full height of 400ft. A tower crane, a Jules-Weitz G60, measuring 456ft from base to top, is being used in the construction of the building.

The project also includes a separate fourteen-storey office block, 194ft high, of reinforced concrete construction, containing some 176,000 square feet of floor space. Between the two blocks a conference hall to seat 1000, having a sprung floor and acoustic control, is under construction. With the exception of the service tower all the buildings are being clad with curtain walling, consisting of glazing and black anodised aluminium panels.

The buildings are to be fully air-conditioned, with air filtration, electrostatic precipitation and humidity control. Engineering plant will also include eight fully automatic express passenger lifts, a goods lift, and ten reversible escalators. A special installation will be an automatic vertical chain conveyor—the first of its kind in the country—for the rapid distribution of documents and mail.

Work on the project, which is being carried out for the Co-operative Insurance Society, Ltd., began in August, 1959, and is due for completion by the middle of next year. The superstructure and a major part of the cladding has now been completed and about 500 men are engaged upon the final phase of the contract, which includes a great variety of finishings. The architects for the development are G. S. Hay, F.R.I.B.A., chief architect, Manchester Co-operative Wholesale Society, Ltd., in association with Sir John Burnet, Tait and Partners. Engineering services are the responsibility of O. Castick, A.M.I.Mech.E., chief engineer, Manchester Co-operative Wholesale Society, Ltd., and the structural engineer is A. E. Beer, E.R.D., A.C.G.I., M.I.C.E., M.I.Struct.E. The main contractor is John Laing Construction, Ltd.

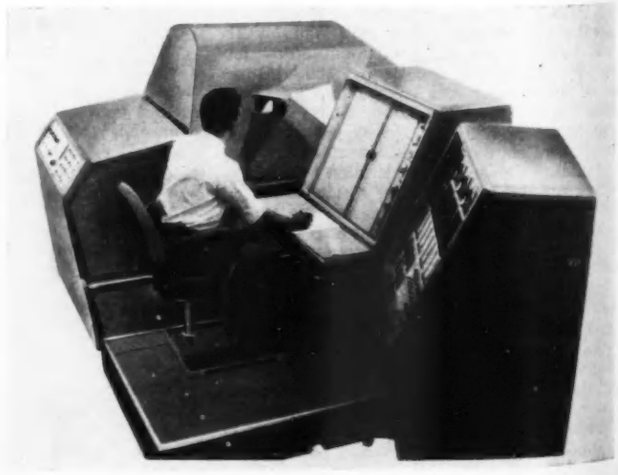
Flight Procedure Trainer

AUTOMATIC simulation of a variety of radio aids is provided in a flight procedure trainer developed by Electronic Control Engineering, Ltd., Burgess Hill, Sussex. The first of this new series of trainers has been sold to the Finnish Air Force.

In the accompanying illustration are seen the cockpit, the track recorder, and the navigation control console. On the latter are eight controls for setting the positions of four beacons which simulate omnidirectional transmissions for training in radio compass procedure, or V.O.R. signals, or both forms of signal together. A fifth beacon at a fixed position provides I.L.S. localiser and glide path signals. Beacon frequencies can be varied during an exercise to provide tuning practice. Call-signs are preset by means of plug-in printed circuit cards. The equipment also enables a variety of faults in aircraft systems, radio receivers and instruments to be indicated to the pupil. The track and approach recorder is in the centre of the installation. This is driven from the flight computer and traces the flight path of the aircraft on a map area approximately 25in square. A control panel includes lights monitoring the pupil's actions, means for setting beacons at different chart positions, and v.h.f. r/t simulation with digital display of the frequency selected.

An electromechanical computer, employing 400 c/s signals and operating as a real-time true analogue, consists of servo units, electronic amplifiers and relays housed in panels in the nose and the sides of the fuselage. Servo units are of open construction for accessibility of components, each consisting of an open framework which plugs into position. Many of the instruments are mounted at the end of the appropriate servo frame for direct drive, to eliminate remote transmitting components and wiring. Two servos are incorporated in one frame where practicable. Computing amplifiers plug into the servo frames and are of a limited range of patterns.

[Reply Card No. 1175]



Simulator installation for training pilots in the use of radio aids

Tractor-powered concrete agitator

Tractor-Drawn Concrete Agitator

A TRACTOR-DRAWN concrete agitator of 3½ cubic yards capacity has been announced by Mackay Industrial Equipment, Ltd. The agitator is mounted on the basic chassis of the firm's "Goose" dumper, so the same tractor—the Fordson "Super Major"—is used for haulage and the same goose-necked type of coupling is employed. The "Goose" dumper was described in THE ENGINEER of April 7 last, page 563.

The firm believes that on many big constructional sites high road speed is not essential for plant of this kind and very often cannot be attained on account of traffic and site conditions. In such cases flexibility and "off the road" performance have great advantages.

As with the "Goose" dumper, the hemispherical coupling on the goose neck permits the trailer to be detached in ninety seconds, thus releasing the tractor for use elsewhere, or to pick up another concrete agitator. A hydraulic jack is built into the base of the goose neck. This jack, which is retracted in the travelling position, is lowered to support and raise the goose neck for detaching the trailer; for further stability two adjustable legs can be fitted at each side of the trailer chassis which are lowered and secured by pins. Hydraulic power is provided by the tractor engine and pump. The hydraulic couplings between tractor and trailer are self-sealing.

The agitator has its own sub-chassis 2ft 10in in width which is bolted to the trailer chassis. The agitator cone rotates at 15 r.p.m. in an all-welded steel "U" frame which is driven by the hydraulic motor through a chain drive. This motor is an Edbro machine, and is air-cooled; it is reversible, reverse rotation being used to speed up loading the mix. The "U" frame supported on trunnions, is tilted by two hydraulic cylinders pivoted to the sub chassis. The maximum loading tilt is 65 deg. above horizontal and the cone discharges at 15 deg. depression into a small hopper carried on the rear frame. Two extension pieces can be fitted to the chute to deliver the mix to the required spot. The hopper and chute can be swung through a wide angle to either side of the trailer.

[Reply Card No. 1172]

Liquid Level Alarm Switch

A STAINLESS steel liquid level alarm switch, Model 26S, of particular interest to the food-processing industry has been introduced by Associated Electrical Industries, Ltd., Instrumentation Division, Harlow, Essex. The carbon steel flange of the switch is clad with a stainless steel plate, presenting to the process an unbroken surface to which deposits will not adhere. Displacer, stop arms and flexible shaft are also of stainless steel. Operation of the switch depends on change in buoyancy of the displacer, and not on movement of a float "riding" on a changing liquid level. Any displacer motion is transmitted to the micro-switch by a stiff tongue within the flexible shaft. Stop arms are provided to ensure that the stress in the flexible shaft is kept within the elastic limit. The micro-switch is operated by a buoyancy change of less than 6 oz, level change of approximately ¼in (12mm) in a liquid with unit specific gravity. The switch and terminal housing is insulated from the flange by an asbestos gasket, allowing it to be operated at process temperatures from 65 deg. Fah. to 350 deg. Fah., with suitable ventilation.

[Reply Card No. 1162]

Instrumentation for Effluent Processing

ON September 27 the Rivers (Prevention of Pollution) Act, 1961, comes into force. Under a previous Act, of 1951, it was necessary for owners of new premises to seek the consent of river boards before discharging industrial effluent or sewage into streams. The new Act extends this obligation to owners of existing premises as well, and means that the occupiers of all premises from which an effluent will be discharged have to provide a certain minimum amount of information regarding the effluent before authority for its disposal can be given. Among the details required is a statement of the quantity to be discharged, and accurate and reliable instrumentation is necessary. As a rule the effluent is at atmospheric pressure, which precludes the use of such liquid flow devices as positive displacement meters or orifice plate/venturi tube meters. Walker Crossweller and Co., Ltd., Cheltenham, has, therefore, evolved equipment for flow measurement based on the well-known vee-notch principle, which has been installed at the experimental effluent processing plant being operated at Southall gas works by the North Thames Gas Board and the Gas Council.

The plant is being used to obtain data on bacteriological treatment of gas works liquor, bacteria having been specially developed for removing phenols and other materials from the liquor. An adequate supply of oxygen is essential to the process and the Southall plant is designed to investigate three different methods of aerating the liquor. There are two parallel liquor treatment systems in operation. In one of these systems there are two towers in which liquor aeration is obtained by circulation of the liquor over a packing while the air passes upwards. The second system uses two tanks, in one of which aeration is by means of an impeller producing vigorous surface agitation, while in the other tank air is blown through the liquor. In all cases the measurement of the throughput is basically the same.

Three of the installations have a maximum flow rate of 500 gallons per hour, and the fourth is at 200 gallons per hour. These are very low rates for measurement by the normal vee-notch method, and the instrumentation involved a compromise between narrow notch angles and low liquid heads. For the 200 gallons per hour flow a notch angle of 34 deg. and a head of 2in has been used, and for the 500 gallon flow, 31 deg. and 3·01in. In setting the weir plates for zero flow with the degree of accuracy required for research purposes a problem arose which was overcome by fitting two hook gauges, one on each side of the notch, so that the centre-line of the vee could be set truly vertical. It was also found necessary to fit covers to the weir tanks, as with the low heads involved, ripples due to wind were sufficient to give false readings.

Hydrostatic Extrusion

A METHOD of extrusion which has been developed at the National Engineering Laboratory is stated to give products with more uniform mechanical properties and to require much lower pressures than the conventional process. In this process extrusion pressure is applied hydrostatically without any direct contact between ram and billet. Tests of the process have so far been restricted to pure aluminium and an aluminium alloy, but the Laboratory is taking the work a stage further by investigating the cold extrusion of other metals, especially steels.

In the new process a cone is machined at one end of the billet so that it fits closely into a die with a conical entry. The die forms the exit from a cylindrical high-pressure chamber containing a liquid, such as glycerine, castor oil, or a dispersion of molybdenum disulphide in oil. The other end of the chamber is closed by the ram of a hydraulic press. As the ram moves into the chamber, pressure builds up in the liquid, which transmits the extrusion pressure to the billet, and the material is extruded through the die without any direct contact between ram and billet. The fluid acts as an efficient lubricant and makes it possible to use conical-entry dies with very small die angles.

The nosing of the billet serves to reduce the amount of work expended in deforming the metal and hence the maximum extrusion pressure required. Reductions in extrusion pressure of 30 to 40 per cent have been obtained in the Laboratory tests. With pure aluminium, the maximum extrusion pressure for the production of rod at an extrusion ratio of 7, through a conical-entry die with a 20 deg. included angle, was 17 tons per square inch compared with a pressure of 32 tons per square inch for a conventional extrusion through a square-entry die. With the alloy (0·7 per cent magnesium, 1 per cent silicon and 0·7 manganese), the pressure was 29 tons per square inch compared with 43 tons per square inch by conventional methods. All these figures are for extrusion from an unheated billet. The distribution of hardness over the cross section of the extruded rod was found to be much more uniform than usual and this will often be an important advantage. The results so far suggest that cold extrusion of high strength materials will be possible.

Launches and Trial Trips

SOLEN, oil tanker; built at Wallsend yard of Swan, Hunter, and Wigham Richardson, Ltd., for Shell Tankers, Ltd.; length between perpendiculars 775ft, breadth moulded 112ft 6in, depth moulded 57ft 9in, deadweight 65,000 tons on 42ft 6in draught; service speed 16½ knots; thirteen centre and twenty wing cargo tanks; two 600kW turbo-alternators; one set of geared turbines, 22,000 s.h.p. at 108 propeller r.p.m., two Babcock and Wilcox "Selectable Superheat" boilers supply steam at 600 lb per square inch gauge and 900 deg. Fah. Launch, June 30.

HOPCREST, cargo ship; built by Barclay, Curle and Co., Ltd., for The Hopemount Shipping Company, Ltd.; length overall 501ft, breadth 63ft 6in, depth to upper deck 41ft 1in, deadweight 14,000 tons (closed shelter deck), 12,000 tons (open shelter deck), service speed 15½ knots; five holds, four forward and one aft of machinery spaces; one 50-ton, ten 10-ton and two 5-ton derricks; four 220kW diesel-driven generators; Barclay, Curle-Sulzer, single-acting, two-stroke, turbo-charged oil engine, five cylinders 760mm bore by 1550mm stroke, 7500 b.h.p. at 119 r.p.m. Trial, July 7.

INDUSTRIAL NEWS

Employment

During July, 1961, the Ministry of Labour says, the number of people in civil employment in Great Britain is estimated to have increased by 39,000 to 23,904,000. This figure is about 210,000 higher than the corresponding figure for July, 1960. During July the number of people employed in the construction industries fell by 15,000 to 1,577,000, in the metal manufacturing group the number employed dropped by 2000 to 631,000, whilst in both the vehicle manufacturing industry and the metal goods group, the numbers employed fell by 1000 in each case. There was no change in the number of people employed in shipbuilding and marine engineering, but in the engineering and electrical goods group there was an increase of 1000 during July bringing the total employed to 2,131,000.

In the week ended July 29, 1961, the Ministry says, the estimated number of operatives working overtime in establishments with eleven or more employees in manufacturing industries was 1,763,000, each working eight hours overtime on average. In the same week, the estimated number on short-time in these establishments was 29,000, losing ten-and-a-half hours on average.

Earnings and Hours

In April, 1961, an enquiry was made by the Ministry of Labour in order to obtain particulars of the average weekly earnings and working hours of manual workers employed in manufacturing industries generally, and in a number of the principal non-manufacturing industries and services in the United Kingdom. The total number of establishments covered by the enquiry was approximately 58,100. The total number of workers, including part-time workers, covered by returns showing the numbers employed and their earnings in the third pay-week in April, 1961, was nearly 7,000,000, and particulars of the aggregate manhours worked in the week were obtained in respect of nearly all of these workpeople.

In the week covered by the survey the average weekly earnings of men (twenty-one years and over) in the manufacturing industries were £15 15s. 3d., the average earnings of youths and boys were £6 17s. 11d., and the average earnings of women over the age of eighteen were £7 12s. 7d. Average weekly earnings for the same three groups in all the industries and services covered by the Ministry's enquiry were £15 1s. 4d., £6 15s. 9d., and £7 12s. 7d. respectively. The average level of weekly earnings rose between April, 1956, and April, 1961, by 28 per cent, the Ministry says, for all men covered by the enquiries and by 27 per cent for all women working full-time. During the half-year October, 1960, to April, 1961, the rise was just over 3½ per cent for men, about 3 per cent for women working full-time, and nearly 4 per cent for juveniles.

According to the survey the average hours worked in the third pay week in April, 1961, by men in the manufacturing industries were 47·3, by youths and boys 43·5, and by women working full-time 39·8. Average hours worked in all the industries and services covered by the enquiry were men 47·9, youths and boys 44·1 and women 39·9.

Agricultural Tractors and Machinery

The Agricultural Engineers Association has announced that the trends in the production, home sales and exports of British agricultural tractors and machinery continue to show slight but steady improvements. Overall, the Association says, production for the first seven months of the year shows a cumulative gain of 3 per cent. Home sales have continued to provide some encouragement, the Association adds, the total for the first seven months of this year being 12 per cent higher than in the corresponding period of 1960. Overseas sales were 4 per cent higher than in the first seven months of 1960.

The Association remarks that in the first five months of this year British tractors valued at £1,900,000 were exported to Germany, whilst German shipments to Britain were valued at £7000. Nearly 50 per cent of German sales are made to the European Economic Community, it adds, whereas the British proportion is about 16 per cent, but as total British tractor exports are some three-and-a-half times greater, British sales to the Common Market including Germany were over £1,000,000 greater than German sales to the other members of the Six. Even excluding Germany, British Common Market sales were only some 10 per cent below the German figure, and have shown a greater growth since last year.

Construction

New orders to the value of £491 million were received by the construction industries in the second quarter of this year, according to the latest figures issued by the Ministry of Works. Although this is lower than the value of orders placed in the first quarter of the year, the Ministry points out that even after allowing for an increase in prices, the reduction between the two quarters was less than normal, and the figure remained well above the level in the second quarter of last year.

Total orders for new housing have been valued at £184 million in the second quarter compared with £175 million in the corresponding quarter of last year. New orders for work for public authorities have been valued at £142 million as against £121 million in the second quarter of 1960, whilst orders for private developers in the second quarter of 1961 were valued at £165 million compared with £156 million in the corresponding quarter of 1960.

Constructional Work Overseas

The Ministry of Works has announced that in the twelve months ended March, 1961, British contractors carried out constructional work overseas to the value of nearly £135 million, an increase of £11,000,000 compared with the previous twelve months. The work was carried out in sixty-three different countries by more than sixty firms. New contracts obtained during the period fell by some £33,000,000 compared with the previous year and the total of £98,000,000 was the lowest figure since 1955. The value of work outstanding at March 31, 1961, was £100 million, £33,000,000 less than the twelve months previously. It is almost certain that the cost of building overseas has risen over the past six years, the Ministry states, and therefore there is a more substantial decrease than the figures taken at their face value show. A number of factors are considered to have contributed to the fall in the value of new contracts obtained. The unsettled political climate in many parts of the world has probably had some effect on the willingness of British contractors to tender, and pressure of work at home has limited the capacity of some firms to accept additional overseas commitments. Competition for overseas civil engineering contracts is growing, particularly from industrialised countries who value the opportunities which such contracts create for their exports of heavy engineering goods. The award of these contracts is often linked with the provision of long-term credit to finance their execution; the British ability to lend more is limited by the balance of payments situation.

The Ministry goes on to say that improvements to the facilities offered by the Exports Credits Guarantee Department, introduced over the last twelve months, should assist United Kingdom contractors to offer prices and credit terms which compare favourably with their competitors both in Europe and North America. Moreover the recently announced economic measures, by reducing the pressure of home demand, should encourage contractors to devote more of their energies to overseas markets. Contracts were secured by British contractors last year in a number of countries where there had been no previous reports of activity since the inquiry started in 1955. For example, contracts have been obtained in the Philippines, Yugoslavia and the U.S.S.R.

Fire Prevention Week

For the first time in Great Britain, a National Fire Prevention Week, sponsored by the Fire Prevention Association and the Royal Society for the Prevention of Accidents, is to be held from October 30 to November 4. One of the aims of the Week is to create an awareness of the main causes of fire and to give elementary guidance on methods of fire prevention. Local campaigns will include fire prevention exhibitions and displays, and fire prevention films are being prepared by the Home Office and the Ministry of Labour. Posters and other publicity material are to be displayed at vantage points throughout the country. Two new fire prevention codes —one for the home and one for industry— are being issued.

For the last two years fire is estimated to have caused the nation about £44,000,000 annually in direct property losses. The damage and destruction of industrial and commercial premises and their contents account for by far the greater proportion of the annual total of United Kingdom fire losses. In 1960, five fires caused 20 per cent of the year's losses. Each year there are between 700 and 800 deaths from fire, and it has been estimated that at any one time, there are about 14,000 people in hospital as a result of fire.

Details of fire precautions in industrial and commercial premises are contained in the new F.P.A./Ro.S.P.A. Fire Prevention Code for Industry published this week.

PERSONAL AND BUSINESS

Appointments

EKCO HEATING AND ELECTRICAL, Ltd., announces the appointment of Mr. J. C. Longman as technical sales manager.

MR. CHARLES B. DE THAN has been appointed European commercial representative for M. and T. Chemicals A.G.

MR. J. R. PETTIGREW, M.I.P.E., works manager of John Fowler and Co. (Leeds), Ltd., has been appointed a local director of the company.

EPSYLON INDUSTRIES, Ltd., a member of the Stone-Platt Group, announces that Mr. C. Garn has been appointed sales manager and Mr. R. A. Edwards, works manager.

MR. G. D. SAUL has been appointed chief inspector of The United Steel Companies' Steel Peech and Tozer branch. He succeeds Mr. W. M. Gladwin, who has retired.

MR. WILLIAM HENRY BESWICK has been appointed assistant superintendent of the meter department at the Motherwell Works of Associated Electrical Industries, Ltd.

THE BRITISH WAGON COMPANY, Ltd., announces that Mr. P. S. Greenhill, manager of its Norwich branch, has been promoted to assistant sales manager at head office, Rotherham.

SANDERS AND FORSTER, Ltd., has appointed Mr. Leonard Pemberton as sales manager to handle the company's home and export sales for purpose-made and traditional structural steelwork.

MR. RICHARD P. E. TABB has been appointed deputy director of engineering of The English Electric Company, Ltd. He will be mainly concerned with the company's technical development programmes.

STILLITE PRODUCTS, Ltd., a member of the Turner and Newall Organisation, announces the appointment of Mr. A. Kyle to the company's technical advisory staff. Mr. Kyle's activities will cover both plant and structural insulation.

MR. KEITH G. HUNTLEY has been appointed chief electronics engineer to Adrema, Ltd., and will be responsible for the formation and building up of the new data processing division to be centred on Adrema's new factory at Cosham, Portsmouth.

MR. A. C. STURNEY has been elected to the board of the International Nickel Company (Mond), Ltd. He has been succeeded as general manager of publicity by Mr. L. F. Denaro, who relinquishes his appointment as assistant to the managing director.

THE PLESSEY COMPANY, Ltd., announces the appointment of Brigadier J. D. Haigh, M.I.E.E., as general divisional manager of a group of divisions including the wiring and connectors division, the capacitors and resistors division, and Preformations, Ltd.

MR. A. PATERSON, M.I.P.E., has been appointed works manager, Trafford Park Works, A.E.I. (Manchester), Ltd., and Mr. A. J. R. Veale, A.M.I.Mech.E., M.I.P.E., has been appointed assistant works manager, with special responsibilities for the manufacturing services department.

RICHARD SUTCLIFFE, Ltd., announces the appointment of Mr. M. W. Seager, A.M.I.Mech.E., A.M.I.Struct.E., as chief development engineer in succession to Mr. Leslie Baines, A.M.I.Mech.E., who, as recently announced, has joined the board of Sutcliffe Hydraulics, Ltd.

HONEYWELL CONTROLS, Ltd., announces the following appointments in its electronic data processing division: Mr. H. La Costa, commercial sales manager; Mr. L. Dilger, A.M.I.E.E., technical sales manager; Mr. M. Hare, manager of applied programming; and Mr. J. Kenny, manager of the E.D.P. centre.

MR. F. WINSTON REYNOLDS, founder of Winston Electronics, Ltd., has relinquished his duties as chairman and managing director of the company, and will now devote the whole of his time to the exploitation of its new range of fully transistorised loudspeaking telephones. Mr. W. Allen Bridges has taken over as chairman and managing director.

THE MINISTRY OF AVIATION announces that Mr. W. Martin-Hurst, a director of the Rover Company, Ltd., has been appointed a new member of the Welsh Advisory Committee for Civil Aviation. The Ministry has also announced the appointment of two new members of the Northern Ireland Advisory Committee for Civil Aviation; they are Air Marshal Sir George Beamish and Councillor S. R. Cochrane.

HENRY SIMON (HOLDINGS), Ltd., announces the following appointments which took effect from August 1, 1961: Mr. E. G. Liebert, director of manufacturing, Henry Simon (Holdings), Ltd.; Mr. J. G. MacLean, managing director, Henry Simon (Engineering Works), Ltd.; Mr. A. H. Bennett, managing director, Turbine Gears, Ltd.; Mr. G. E. Haywood, director, Henry Simon (Engineering Works), Ltd., seconded as personal assistant to Mr. Liebert. Mr. Liebert's appointment follows the board's decision to use the Henry Simon (Holdings) Companies' manufacturing facilities to the best advantage and to make available a manufacturing advisory service to all managing directors. He has relinquished his managing directorships and remains an ordinary director of Henry Simon (Engineering Works), Ltd., and Turbine Gears, Ltd.

Business Announcements

DU PONT COMPANY (UNITED KINGDOM), Ltd., states that the price of "Teflon" TFE-fluorocarbon resin has been reduced by 4s. a lb.

B.T.R. INDUSTRIES, Ltd., announces the retirement of its deputy chairman and former managing director, Mr. P. W. Howard, upon his attainment of the age of seventy.

THE LAPOINTE MACHINE TOOL COMPANY, Ltd., has now completed extensions to its plant at Watford, Herts., which will add 10,000 square feet to its total factory area.

MATCHLESS MACHINES, Ltd., states that its offices, stores and demonstration rooms are now located at Matchless Works, Crawley Road, Horsham, Sussex (telephone, Horsham 60271).

MASSEY-FERGUSON'S new associate company in India, Tractors and Farm Equipment, Ltd., Sembiam, Madras, announces that it is now producing M-F.35 tractors. They are powered by locally manufactured Perkins diesel engines.

PIPELINE ENDURANCE, Ltd., Woolmer Green, Knebworth, Herts., has formed a separate division to deal with cathodic protection for corrosion control in sea water circulating water systems. Mr. G. G. Page has joined Metal and Pipeline Endurance, Ltd., to head the new division.

MR. P. R. SCUTT, managing director of Tecalemit, Ltd., left for America on September 7. He will return on September 20. The object of his visit is to extend the company's business in the U.S.A., and to attend a board meeting of Imperial-Eastman Corporation of Illinois, of which company he is a director.

THE PLESSEY COMPANY, Ltd., announces the conclusion of negotiations to lease from the Swindon Corporation a further 50,000 square feet factory at Cheney Manor, Swindon. The factory, which is close to the existing Plessey factory group at Cheney Manor, is expected to be used for expansion of the company's Industrial Hydraulics Division.

BRITISH ERMETO CORPORATION, Ltd., and its associate company, SIMPLIFIX COUPLINGS, Ltd., both members of the Alenco Group, are to open a depot on October 2, 1961, in Blackett Street, off Fairfield Street, Manchester (telephone Ardwick 4558), in order to provide an improved delivery service for its customers in the Manchester area. Stocks of Ermeto and Simplifix standard couplings, valves, hose and tube will be available.

TUBE INVESTMENTS, Ltd., announces the acquisition of a 280-acre site at Washington, Co. Durham, for the long term development of its manufacturing capacity. It is expected that preliminary site work will begin early in 1962 and that by 1965 some 750 men and women will be employed in the manufacture of steel tubing. The first factory will house an electric resistance welded tube mill. The ultimate labour force is expected to exceed 3000.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., states that the A.E.I./Davy-United Steelworks Automation Unit, which was formed in July, 1960, to apply automation to the processing of steel and non-ferrous metals, will henceforth trade in its own right. The interests of Associated Electrical Industries Ltd., and Davy-Ashmore, Ltd., in this field are now combined in a jointly owned company, Davy-A.E.I. Automation, Ltd. Chairman of the new company is Mr. M. A. Fiennes, managing director of Davy-Ashmore, Ltd., and the vice-chairman is Mr. C. R. Wheeler, vice-chairman of Associated Electrical Industries, Ltd. The headquarters of the company will be located at Booths Hall, Knutsford, Cheshire.

COOKE, TROUGHTON AND SIMMS, Ltd., announec that the following changes in organisation will become effective at October 1, 1961. Mr. P. D. Scott Maxwell, M.I.Mech.E., relinquishes his appointment as managing director on taking up his appointment with Vickers-Armstrongs (Engineers), Ltd., but retains his seat on the board. He also relinquishes his appointments as chairman and director of C. Baker Instruments, Ltd.; director of Cooke, Troughton and Simms South Africa (Proprietary), Ltd.; president and director of Cooke, Troughton and Simms Incorporated; director of Casella (Electronics), Ltd. Mr. H. Wright is appointed managing director and becomes chairman of C. Baker Instruments, Ltd.; director of Cooke, Troughton and Simms South Africa (Proprietary), Ltd.; president of Cooke, Troughton and Simms Incorporated. Mr. A. J. Munro, A.M.I.Mech.E., A.M.I.Prod.E., is appointed engineering director and will be responsible for the technical departments in addition to production. He is also appointed a director of Cooke, Troughton and Simms Incorporated. Mr. E. E. Kennaird is appointed a director of Casella (Electronics), Ltd. Mr. E. Cussans, M.I.Prod.E., is appointed works manager of Cooke, Troughton and Simms, Ltd. Mr. S. S. L. Marshall becomes commercial manager of Cooke, Troughton and Simms, Ltd., in addition to his existing appointment as secretary.

Contracts

HUMPHREYS AND GLASGOW, Ltd., has received a contract worth £300,000 for the design and installation of refinery gas reforming plant at Granton, Edinburgh for the Scottish Gas Board. This Onia-Gegi plant will comprise two units reforming refinery gas to produce a maximum output of 18,000,000 cubic feet per day of 450 B.Th.U. town gas, and it will also be capable of reforming butane if required. This equipment has a single reactor vessel which could be modified in future for light distillate reforming and it will be the first of the Onia-Gegi type to be built in Scotland.

THE ENGLISH ELECTRIC COMPANY, Ltd., and the BRUSH ELECTRICAL ENGINEERING COMPANY, Ltd., have received orders from the Rhodesia Railways for 3ft 6in gauge diesel-electric locomotives. Sixteen $1C_0$-$C_0$1 units of 1875 h.p. to be supplied by the English Electric Company, Ltd., will be manufactured by the Vulcan Foundry, Ltd., Robert Stephenson and Hawthorns, Ltd., and the English Electric works at Preston in collaboration with each other. This order is valued at some £1,300,000. The Brush order, stated to be worth approximately £1,250,000, is for fourteen C_0-C_0 locomotives with Mirrlees JVS12T engines, fitted with HSBT turbochargers and developing 1730 b.h.p. under the climatic conditions in Rhodesia. Manufacture will be carried out in the Brush works at Loughborough. These locomotives are for service between Bulawayo and Malvernia.

FERRANTI, Ltd., has received an order from the Central Electricity Generating Board for four 570MVA, three-phase, 22kV/430kV delta/star-connected, 50 c/s, double-wound generator transformers, to be installed at West Burton power station, Notts, where they will connect four 500MW turbo-generators to the supergrid. High-speed resistor-transition on-load tap changing gear will cater for voltage variations of ± 10 per cent in eighteen steps. The cores will be of minimum-bolted, five-limb backbone construction, employing full 45 deg. mitreing of all joints for lowest possible core loss and magnetising current. This construction will bring the units within permissible loading gauges, and core clamps and tanks will be of aluminium to keep the weight within transport restrictions. A complete transformer stripped for transport will weigh 215 tons, and dimensions will be 32ft 6in long by 13ft 6in wide and 16ft 2in high. Value of the order is over £1,000,000. The units are said to be the largest generator transformers in the world.

Death

WE regret to record the death on September 5 of Mr. Leo B. George, a former Chief of Motive Power and Rolling Stock on the Canadian Pacific Railway. Mr. George began his career with the C.P.R. at the age of fourteen. His early appointments were in locomotive shops in various parts of the system, and in 1946 he became Assistant Superintendent of Motive Power, Western Lines. A year later he was appointed Assistant Chief of Motive Power for the system, and became Chief of Motive Power and Rolling Stock in 1957.

South African Harbour Developments

By OUR SOUTH AFRICAN CORRESPONDENT

THE major harbours along the South African coast can accommodate the largest ships afloat alongside berths equipped with electric cranes and modern harbour facilities. Walvis Bay, with serves South West Africa, has also had to be improved to meet progressively expanding demands arising from the increased prosperity of the territory, while Mossel Bay, for many years only a fishing harbour, has become an oil port which serves the south-western districts of the Cape Province and is a regular port of call on the coastal route. At the end of 1960 the position of the various ports was as follows.

Cape Town.—Table Bay, the oldest harbour in South Africa and one of the most important in the southern hemisphere, occupies a strategic position on the world's sea routes. It has three enclosed docks—the Victoria basin, the Alfred basin and the Duncan dock, with a total acreage of 365 and a total quay length of 24,380ft. Seven tugs, of which four are equipped with wireless telegraph, telephone, salvage and fire-fighting equipment, and three with radar, have been assigned to the port.

There are two large dry docks, the Sturrock and the Robinson docks. The Sturrock dock is one of the largest graving docks in the world, with a length of 1110ft, which can be extended to 1212ft by placing the caisson in the emergency stop at the entrance. One 50-ton, one 10-ton and two 5-ton electric cranes serve this dock. The other dry dock, the Robinson dock, has a length of 468ft and has one 4-ton electric and one 1½-ton steam crane. An offshore floating dock 137ft long and 31ft wide with a lifting capacity of 450 tons can take vessels up to 23ft in beam, and there is also a patent slip for craft up to 500 tons, with additional accommodation for two vessels of 300 tons each on side-slips. Shed and storage accommodation with a floor space of 822,431 square feet and 9,457,959 cubic feet capacity is available. Handling equipment includes 100 electric cranes with various lifting capacities, a floating crane capable of lifting 60 tons at 80ft radius, and a grain elevator of 30,000 tons storage capacity. Coal storage sites are provided. Table Bay harbour has twenty-three bulk-oil storage tanks with a capacity of 51,270 tons for petrol, and fourteen tanks with a capacity of 24,763 tons for paraffin. Fuelling of vessels presents no problem. Work on the fruit pre-cooling stores is practically complete. After the fire in 1958, new plans were prepared and approximately £4·5 million was spent on new and additional accommodation. The present capacity is 15,114 shipping tons, but the capacity will shortly be 17,000 shipping tons. An interior view of the pre-cooling stores is shown in Fig. 1.

New developments in Table Bay include a 900ft lead-in wharf from the entrance to the Sturrock dock, and the widening of the entrance to the Duncan dock. The construction of the lead-in wharf was decided on to overcome the difficulty in high winds of dry-docking the super-tankers, which have now become regular callers at Table Bay. This lead-in wharf will make it comparatively easy to bring ships to the wharf with the aid of tugs and thereafter warp them into the dry dock by means of winches and capstans. The widening of the entrance to the Duncan dock will take more than a year to complete. The entrance will be widened by 200ft to a new width of 600ft, and will permit the large ships to enter or leave the port in poor weather in safety, as they will be able to manoeuvre at an angle against unfavourable winds.

Another useful addition to the facilities at Table Bay was the installation, during 1960, of a coaling plant for tugs and trawlers at the West Quay, Alfred basin. This plant is capable of handling approximately 100 tons of coal per hour, and can deal with vessels from the largest ocean-going tug to the smallest trawler, and reach any desired hatch-opening when coaling the vessel. An interesting feature of this plant is that it is push-button controlled by a single operator on the quayside, who has a clear view of the coaling point.

Durban.—Durban, or Port Natal, is the main port serving the highly developed industrial area of the Witwatersrand and is also the principal coaster port of the Republic, with sixteen coasters on the port's register. It has a total of 29,834ft of quayage worked by 101 electric cranes, the largest of which has a capacity of 80 tons. Shed accommodation consists of 787,414 square feet with a capacity of 8,858,408 cubic feet. The pre-cooling store has accommodation for 1800 shipping tons, and the grain elevator has a capacity of 42,000 tons. There is a privately-owned electrical conveyor plant capable of shipping 500 tons of manganese ore per hour. Privately-owned bulk-oil storage and oil-fuelling facilities with 142 tanks have an aggregate capacity of 408,600 tons. The coaling facilities are capable of an aggregate of 4400 tons per hour. The port is served by six harbour tugs equipped with wireless telegraph, telephone, salvage and fire-fighting appliances. One tug is also equipped with radar. Two pilot tugs equipped with wireless telephone and one second-class tug are also available. In Fig. 2 there is reproduced a photograph of the F.C. "Sturrock," one of Durban's most powerful tugs. The repair facilities consist of a graving dock, 1150ft long, served by one 25-ton, one 10-ton, two 5-ton and one 3-ton cranes, together with a floating dock of 350ft with a 4000-ton lifting capacity.

Considerable new development is taking place in this harbour. The most important project is the construction of an ocean terminal on the "T" jetty. This terminal, when completed in December, 1961, will be one of the most modern in the world. A telescopic gangway will provide an enclosed passageway between liners at berth and the passenger reception hall in which the Customs and Immigration authorities will have offices. Refreshments and meals will be served in tea rooms and restaurants equipped with up-to-date kitchens, while cars and taxis will be parked in large parking areas close by.

A new shed 900ft by 120ft, and a pre-cooling chamber of 4000 cubic tons capacity, are being built on the ground floor of the ocean terminal. One of the most impressive sights there is the row of double doors, shown in Fig. 4, made of gleaming aluminium sheet, extending for a distance of more than 600ft. The doors are at the entrances to the fifty-four cooling tunnels in which fruit, destined for export, is cooled to just above freezing-point before being shipped. Fig. 5 shows the entrance to one of these cooling tunnels. Prime export fruit—a valuable source of income to South Africa but a highly perishable commodity—is receiving "V.I.P." treatment at this terminal to ensure that it is shipped overseas in the best possible condition. The terminal's ultra-modern facilities allow the handling of fruit to be kept to a minimum and for it to be speedily cooled to shipping temperatures, which is vital if it is to arrive at its destination without suffering deterioration. The fruit, which arrives by rail from all over Natal and the Transvaal, is unloaded at the terminal into a sorting area immediately adjacent to the pre-cooling rooms on the first floor of the building. It is then stocked on pallets and moved by fork-lift trucks straight into the pre-cooling tunnels in which the temperature is kept just above freezing point.

To ensure that the pre-cooling rooms operate with maximum efficiency it is important that particular attention be paid to the insulation of the compartments. It is, therefore, interesting to note that the designers, M. S. Zakrewski and Partners, specified aluminium alloy sheet for the cladding of the doors despite its high conductivity. Over 20,000 square feet of aluminium sheet have, in fact, been used for cladding. Because aluminium requires no protective painting, even in marine climates, its use results in negligible maintenance costs. The cooling tunnels are 11ft 6in wide and 75ft long and will hold 81 tons of fruit or other perishables, giving the terminal a total capacity of 4374 tons.

A conventional brine refrigeration plant with

Fig. 1—Interior view of new pre-cooling stores at Cape Town

Fig. 2—One of Durban's powerful tugs, the "F.C. Sturrock"

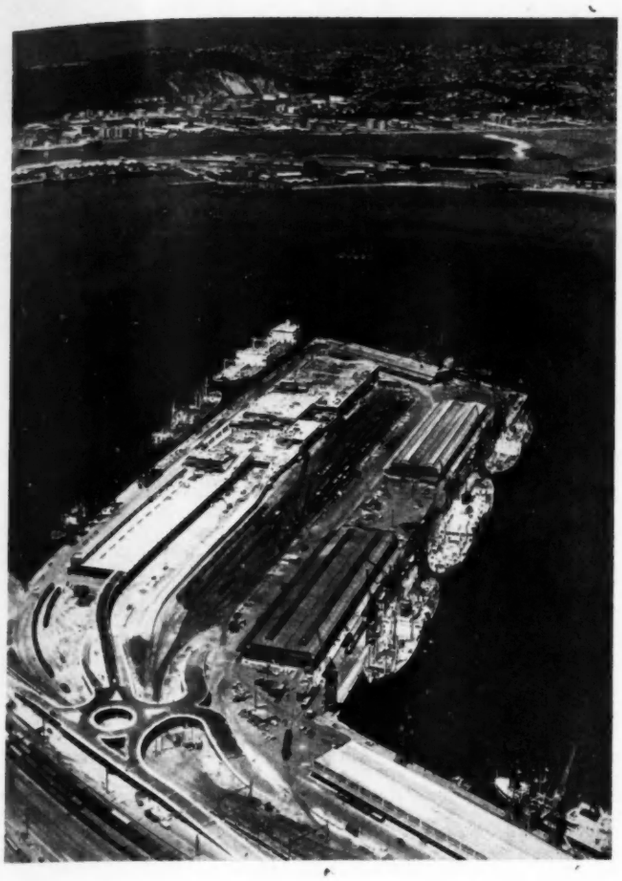


Fig. 3 — Aerial view of Durban harbour, showing the modern Ocean Terminal under construction at the "T" jetty. The elevated roadway will give access to the terminal building and parking area, unhindered by trains or cranes. Salisbury Island and the oil sites can be seen in the background

individual controls to each tunnel has been installed by Airco Engineering, Ltd., with aluminium sheeting and fibreglass as the insulation and vapour barrier materials. Tribute should be paid to both the designers and to the principal contractors, Roberts Construction Company, Ltd., as the new terminal is reputed to be one of the most modern in concept to be built anywhere in the world.

Further improvements at Durban harbour include the dredging of a 1400ft turning basin, certain reclamation work, and the construction of a new berth, all at Island View. These developments should be completed by the end of 1961. Ship repair facilities will be concentrated at the Bayhead. A concrete jetty 700ft long by 40ft. wide is being built for the purpose.

Port Elizabeth.—Port Elizabeth (Algoa Bay) is the major eastern Cape port. It is strategically situated to handle traffic to and from the Rhodesias and is only 714 miles from Johannesburg, the centre of the Witwatersrand. The port has deep water quayage of 6540ft and accommodation for large tankers. It has storage accommodation for 5,959,733 cubic feet of cargo in sheds with a floor space of 529,754 square feet and has a cargo stacking area of approximately 141,620 square feet. Quayside pre-cooling facilities for approximately 7260 shipping tons are available and the privately-owned bulk-oil storage tanks have a capacity of 109,278 tons of petrol, paraffin and fuel oils. Sixty-one electric cranes with lifting capacities of from 4 tons to 15 tons have been installed, and repair facilities consist of an electrically operated slipway, 810ft long with a capacity of 1200 tons displacement, and capable of accommodating one vessel of 800 tons on the side-slip. Two first-class tugs equipped with salvage and fire-fighting appliances, wireless telegraph and telephone installations, and one pilot tug with salvage and fire-fighting appliances and wireless telephone are stationed at this port. Fig. 8 shows cargo vessels lined up at the harbour.

The largest motor assembly plants in the country are established in Port Elizabeth and motor vehicles form an important part of the traffic carried inland from the port. Port Elizabeth's importance will be further enhanced with a new 1200ft long bulk cargo berth at which export ore and mineral traffic can be handled. The ore berth is being constructed to a depth of 40ft and will be equipped with the best available type of mechanical handling appliances. The target date for the completion of this work is March, 1962.

East London.—East London (Buffalo harbour) is the only river port of the Republic and is well situated for serving the Orange Free State goldfields. The regrading and deviation of the Cape Eastern main line from East London to Springfontein has increased the carrying capacity of the line. Train services have been speeded up and, since the introduction of express goods services, cargo from this port is now delivered to the Witwatersrand industrial area on the second day after acceptance.

The port has a quayage of 7384ft served by seventy-four electric cranes of 3, 4, 5, 10, 15 and 20 tons lifting capacity. Sheds of 259,758 square feet, capable of accommodating 2,903,824 cubic feet of cargo, and 8·7 acres of open ground storage for rough goods, together with a maize storage shed with a capacity of 120,000 bags, are available. The pre-cooling stores can accommodate 2400 shipping tons of citrus and deciduous fruit, and the bulk oil storage facilities consist of forty-six privately-owned tanks, with a capacity of 107,390 tons of petrol, paraffin and fuel oil. There are nine bunker points for delivery of fuel oil to vessels.

The port has a dry dock—the Princess Elizabeth dock—with a length of 633ft, served by two 15-ton and one 5-ton electric cranes, together with a slipway of 1000 tons displacement capacity. There are three powerful tugs and two pilot tugs. In addition to one tug equipped with radar, all three have fire-fighting appliances, direction finding apparatus, wireless telegraph and telephone installations, and the two pilot tugs are equipped with wireless telephones.

Being a river port the shipping accommodation at East London in the old days was restricted, and as far back as 1935, considerable expansion had to be undertaken in the form of an enlarged turning basin which enabled the largest ships then in service on the South African route to be turned round and docked safely. With the advent of larger ships and the progressive economic expansion in post-war years it became necessary to further enlarge the port and a major project, which virtually meant the carving of a port in solid rock, was started in 1957. The work entailed the enlargement of the turning basin to 1200ft wide and 1800ft long, the construction of a new quay, 1270ft long, equal to

Fig. 4—Row of double-door entrances to fifty-four pre-cooling tunnels

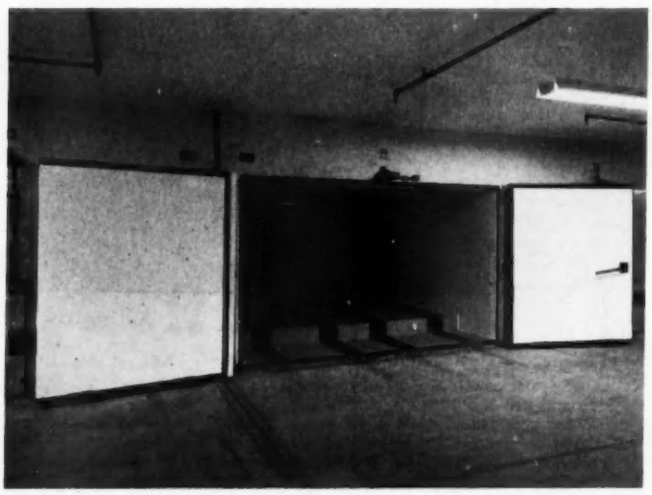


Fig. 5—Entrance to one of the cooling tunnels at Durban's Ocean Terminal

Fig. 6—Wool cargo being exported from East London

Fig. 7—Merchandise being off-loaded at Mossel Bay

two commercial berths, a new oil tanker berth 850ft long, and widening of the entrance channel to 600ft, together with the deepening of the turning basin area and the entrance channel to 35ft L.W.O.S.T. The work is nearly complete. All that remains to be done is the final finishing work. The turning basin was tackled in two stages, first, the widening to 1070ft to accommodate the "Pendennis Castle," which made her first call at East London early in 1959, and then to 1200ft to accommodate the "Windsor Castle" (38,000 tons) on her maiden voyage in September last year. Fig. 6 shows wool cargo for export from East London harbour.

Walvis Bay.—Walvis Bay, the Republic port serving South West Africa, has a quayage of 1500ft served by ten 4-ton, two 3-ton and one 7-ton electric cranes, and has storage accommodation of 60,000 square feet on covered floor space, 50,000 square feet on uncovered platforms, 79,000 square feet of uncovered ore platforms, and unlimited storage ground for rough goods. Privately-owned bulk-oil storage facilities can accommodate 18,072 tons of petrol, 8365 tons of gas oil, 6615 tons of paraffin, and 8279 tons of light diesel oil in twenty-one tanks, while three fuel oil tanks of an aggregate capacity of 3953 tons are available and ships can be coaled by crane at the rate of 25 tons per hour. Fresh-water can be supplied to vessels at the rate of 15 tons per hour. The port has two first-class tugs and one pilot tug, fitted with radar, wireless telegraph and telephone installations and salvage and fire-fighting appliances. Repairs to ships can be carried out on a 685ft long slipway with accommodation for three vessels at a time, side-slips being provided to take one craft on each side of the main cradle.

A harbour improvement programme is under way at this port and is scheduled for completion towards the end of this year. The quay is being extended by 3100ft and will thus provide an additional five berths of approximately 600ft each, and bring the total number of berths in the harbour to eight. Additional shed accommodation consisting of two sheds, each of 4000 square feet, will be provided at Nos. 5 and 6 berths, which were scheduled to be completed in March, 1961, and July, 1961, respectively. One new 15-ton and fifteen 4-ton cranes are being provided to bring the total number of cranes at the port to twenty-nine. The area behind the new quay wall is being reclaimed and the whole harbour area dredged to a depth of from 33ft to 35ft L.W.O.S.T.

During June, 1960, a new reinforced concrete dolphin type tanker berth was placed in service. This berth is a mile and a half from the main quay and can accommodate tankers up to 630ft in length. The berth has a depth alongside of 33ft L.W.O.S.T.

Fig. 8—Cargo vessels lined up in Port Elizabeth harbour

Mossel Bay.—Mossel Bay, which serves the south western districts of the Cape Province, has recently been provided with a privately-owned undersea oil pipeline, which is the first of its kind in the Republic, and has provided this port with an important place on the map.

Although mainly a coaster port, Mossel Bay is nevertheless equipped to handle the traffic for the area it serves. Fig. 7 shows merchandise being off-loaded at the port. The port has shed and storage accommodation with a floor space of 13,300 square feet and 206,000 cubic feet capacity. Fourteen lighters of aggregate capacity 1745 tons two 4-ton electric cranes and one 2-ton hand crane are used for the handling of cargo. There are two tugs equipped with salvage and fire-fighting appliances and wireless telephone.

Acknowledgment is made to Alcan Aluminium of South Africa, Ltd. for the photographs of Figs. 3 and 4, and to the South African Railways and Harbours Administration for the remaining photographs accompanying this article.

New Monrovia Port Facility

At the Free Port of Monrovia, in Liberia, construction has started on a further major port improvement—an ore-loading pier. This project is designed to meet the needs of Liberia's economic expansion and its growing exports of iron ore, rubber, latex and palm kernels. The new facility, a 855ft finger pier, will be utilised by Liberia Mining Company in shipping to world steel markets high-grade iron ore dug from extensive deposits in the Bomi Hills mines just 43 miles inland.

The contract for the construction of the pier—and twelve dolphins—was signed in New York in July by Vice-Admiral George Wauchope, U.S.N.R.(Retd.), President of the Monrovia Port Management Company, which operates the port as managing agent for the Government of Liberia, and by John A. Guissinger, vice-president of Raymond International Liberia, Ltd., the contractors.

The pier will accommodate vessels of up to 35ft draught and will give the busy port one of the most modern and efficient ore-loading facilities in the world. There will be a maximum loading capacity of approximately 2500 long tons of natural fines and concentrates per hour, or 1690 long tons of lump per hour. Loading will be carried out from either side of the pier and will greatly speed up shipment operations now done from the existing Liberia Mining Company wharf.

By shifting the ore-loading to the new pier, some 850ft of wharf space will be freed for servicing dry cargo vessels. This section of the port will then be able to accommodate two additional medium size cargo vessels, or three smaller ones, at its total wharf length to some 2000ft overall.

On either side of the new pier there will be six dolphins—clusters of steel piles—sunk vertically into the harbour bed to hold vessels several feet off the quay during loading. Piling for the pier will be of all-steel construction, and cathodically protected to prevent corrosion.

The estimated cost of the new construction work is 1,400,000 dollars and its completion is scheduled for January, 1962. Raymond International will furnish all engineering and supervisory personnel, labour, tools, erection and construction machinery.

CONTINENTAL AFFAIRS

by Our Continental Editor

European Machine Tool Exhibition

No. II—*(Concluded from page 417, September 9)*

In this article we continue our notes on some of the machines shown at the seventh European Machine Tool Exhibition which closed at Brussels on Tuesday last, September 12. There were but few machines of new design to be seen—although many shown at previous exhibitions incorporated developments designed to increase speeds and capacity, reduce setting times or to widen an existing range. One of the noticeable features was the increase in the number of types of machines to which programming equipment, tape and numerical control equipment has been added, and the reductions which have been made possible in setting and production times.

An automatic turret drilling machine introduced by David Brown Industries, Ltd., Trafford Park, Manchester, and developed in collaboration with E.M.I. Electronics, Ltd., is illustrated in Fig. 7. This machine has a co-ordinate table positioning range of 15in by 30in and its maximum drill capacity is 1½in. It is available with two forms of electronic control—leadscrew measurement and control and precision control using "Emicon" conductors for slide position measurement. The sixteen spindle speeds from 80 to 4000 r.p.m. are selected through an electro-magnetic gearbox and each spindle is provided with a dial for speed selection purposes. The turret head is hydraulically controlled and gives feed rates up to 5in per minute for fine feed and 120in per minute rapid feed.

The machine can be used for three forms of automatic cycle working—single turret indexing when drilling; repeat turret indexing for drilling; and repeat turret indexing for milling. When single turret indexing is used control of the turret position is effected by pushbutton, and each operation of the button is followed by a complete single index operation.

Having selected the required drilling spindle, operation of the auto-cycle start button starts the drill cycle, which commences with drill advance, finishing with drill withdrawal. This method is particularly useful when making a trial run. When milling, the head rapidly feeds to the workpiece, reducing to fine feed if necessary, and remains at the preset depth until all table movements are complete. The head then rapid-traverses away from the table.

When using the repeat turret index sequence, turret indexing is automatic at the end of each drilling cycle, the sequence continuing until all drilling operations are complete.

An interesting machine exhibited by Georg Fischer A.G., Schaffhausen, Switzerland (Vaughan Associates, Ltd., 4, Queen Street, London, W.1) was developed in conjunction with the New Britain Machine Company of the United States. With this machine (Fig. 8) copy turned components can be produced up to 9in diameter and 3·9in long from tube stock up to 13ft long accommodated in the magazine. The machine is based upon the KDM 18/70 copying lathe and has the same design and capacity copying slide, saddle, &c. New elements incorporated include the headstock, tube feed, infeed attachment, cutting-off attachment and unloading device.

The headstock, which is integral with the left-hand column of the machine, has a 45 h.p. driving motor, the spindle speed range available being from 140 to 595 r.p.m. This spindle, with a bore of 9in, is fitted with a collet chuck with interchangeable jaws to provide for different stock diameters. The collet is opened by compressed air and the clamping loading is provided by Belleville springs. In the air-operated tube feed unit two feed blocks are used to push the tube towards the headstock up to a step which swings into its operative position after each workpiece has been parted off.

The new cutting-off attachment mounted on the headstock has two slides controlled by dogs, one slide being used for a rough plunge cut and the second, which follows it, to complete the parting-off operation. An unloading ram catches the parted-off workpieces and deposits them in a basket mounted on the headstock.

Another new Fischer machine is an automatic facing and centring machine for workpieces from 6in to 22in long and 0·6in to 6·3in diameter. The machine can, if required, be linked to a copy turning machine to provide an automatic feed of faced and centred stock to the lathe loading mechanism. In the machine two centring and facing heads are set one on each side of a chain conveyor used for delivering and removing the bars. As each incoming workpiece is positioned between the heads the conveyor stops, and the workpiece is automatically clamped and centred for the facing and centring operation at both ends. After machining the workpieces are released on to the conveyor for transfer to the buffer magazine of the copying lathe.

A prototype of a new design of jig boring machine which was shown by Dixi S.A., Le Locle, Switzerland (Dowding and Doll, Ltd., London), was fitted with automatic numerical positioning equipment stated to give settings within 0·00005in. With this combined optical and tape positioning equipment co-ordinate positioning can be effected by means of a keyboard or through a punched tape which also controls the traverse speeds, spindle speeds and other functions. The tape for a sequence can be perforated automatically in the initial keyboard setting on the first workpiece of a batch. If required the machine can be operated manually with reference to the optical setting equipment.

The machine has a 32in square worktable with longitudinal and transverse traverses of 28in and 21in respectively, and its spindle slide has a vertical movement of 21½in. Spindle speeds

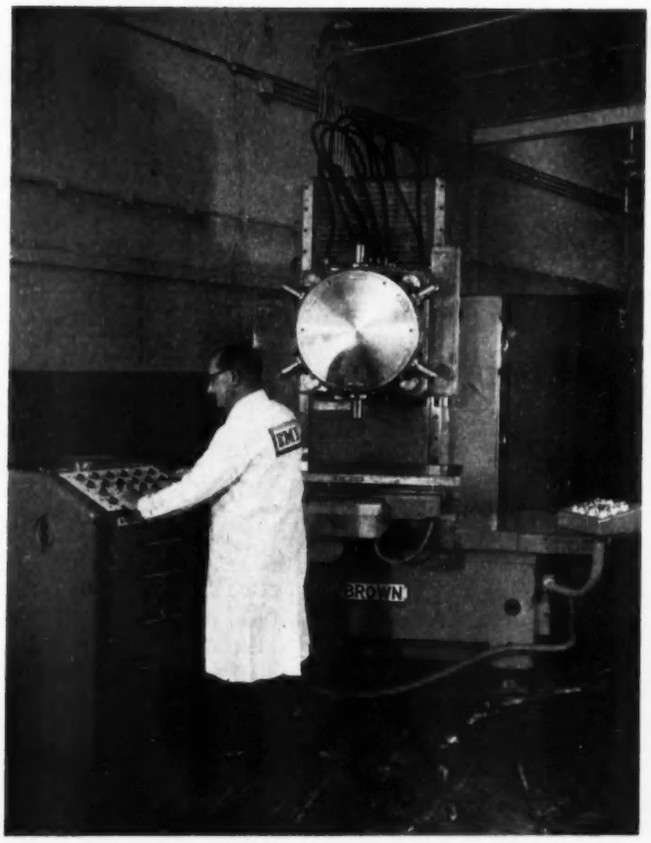


Fig. 7—Turret drilling machine with electronic control of drilling cycle —David Brown

CONTINENTAL AFFAIRS *(Continued)*

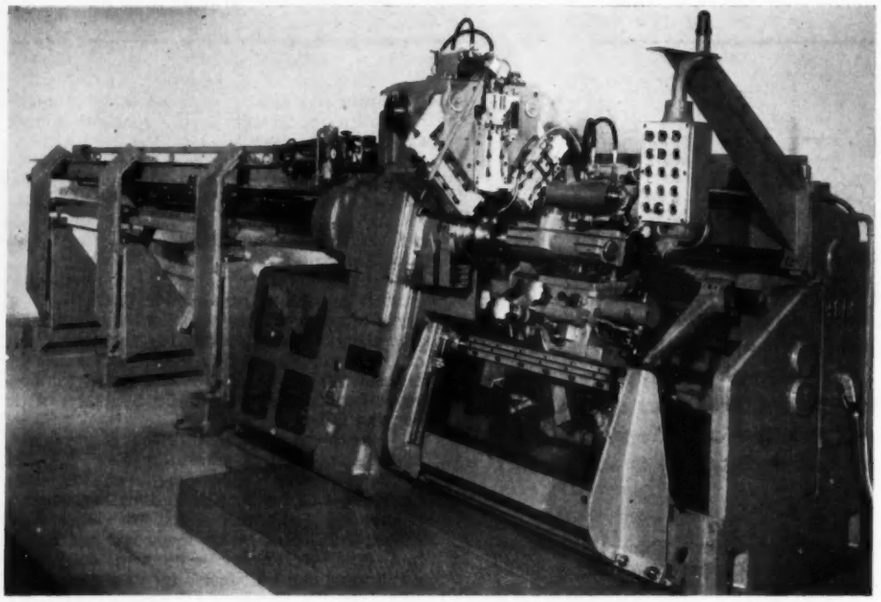


Fig. 8—Copying lathe set up for producing bearing races from tube stock—Fischer

from 35 to 2500 r.p.m. are available and all motions are hydraulically actuated at stepless speeds up to 118in per minute. As distinct from earlier Dixi machines the new design is of twin column design, the two columns carrying the head being placed close together and having vee-ways on the front and flat ways on the rear. The front column is of heavier construction than the rear column to provide for the transverse stresses during machining.

An unconventional method of imparting rigidity to a machine tool bed to dispense with special foundations has been adopted for the "Komplemat" lathe by Gebr. Heineman A.G., St. Georgen, Germany (Hardinge Machine Tools, Ltd., Feltham, Middlesex). This machine has a light welded base which is filled with reinforced concrete and it requires only to be placed in position on a sheet of rubber to accommodate unevenness in a floor. The machine is available in various bed lengths and by using different units can be arranged as a copying lathe, a multi-tool automatic, a turret lathe or a combined copying and turret lathe. Programme control equipment is incorporated in the headstock.

Machines shown by Schiess A.G., Dusseldorf, Germany (Burton Griffiths and Co., Ltd., Kitts Green, Birmingham, 33) included the model "KZ 250" double column vertical boring mill illustrated in Fig. 9. This machine is fitted with a side head profiling attachment, a "C.M. Magic" measuring device, precision setting and measuring equipment, and a combined taper-turning and thread-cutting attachment. The mill is designed to take work weighing up to 8 tons and 106in diameter on its table, which has sixteen speeds any of which can be preselected and engaged directly without intermediate steps.

The exhibition machine was the first of its class to be fitted with the "C.M. Magic" measuring device for the right-hand cross rail head, which enables the tool to be set to the desired machining diameter to an accuracy of 0·0004in. This head is also equipped with a precision setting device to permit positioning from the pendant station when the table is stationary or rotating. The measuring device enables the horizontal traverse of the head to be read off through an optical system and two silicon photo-conductive cells on the precision scale incorporated in the cross rail, and transmitted electrically to the right-hand pendant station where, with the aid of decade digital indicator tubes, the position of the tool and, consequently, of the turning diameter is indicated. When the desired diameter is attained a "magic eye" indicates coincidence. To provide micro-reading of the angularity when a cross rail head is swivelled to the right or left, the machine is equipped with an optical clinometer. This instrument can be employed for both cross rail heads, which are fitted with special mounting plates to permit easy changing from one to the other. The combined taper-turning and thread-cutting attachment enables English, metric and module threads to be cut, as well as scrolls, whilst angles up to 45 deg. can be taper-turned.

A Schiess "KEFA 80" automatic vertical turret lathe shown was fitted with numerical control equipment. With this equipment the input and storage of control and positioning data for both axes are effected by a plugboard, by the use of which the sequence of operations and the traverses are determined by plugs. The lengths of travel are ascertained by a digital measuring system, the actual value indication being by means of illuminated digits on the switch cabinet. Also incorporated in the switch cabinet is the counting system with the set-actual value comparator. The operational sequence can be interrupted at any desired point. The length of travel can be varied as and when required without trouble, so that dimensional corrections can be easily made.

The largest and the smallest sizes from the range of centreless grinding machines made by Lidköpings Mekaniska Verkstads A.B., of Sweden (Drummond Asquith, Ltd., Birmingham), were shown in operation at Brussels. The largest machine, known as the "5B" is illustrated in Fig. 10. It is designed for through-feed grinding and handles light work from 0·20in to 13in diameter, heavy work up to 10in diameter, and bars and tubes up to 8in diameter—at the exhibition the machine was engaged in the continuous through-feed grinding of 5in steel bars. According to the class of work main driving motors from 60 h.p. to 100 h.p. can be provided and the drive to the grinding wheel, which has a maximum speed of 910 r.p.m., is transmitted through vee-belts.

Grinding wheels up to 26in diameter used on the machine can be of 14in normal and 16in maximum width and, like the control wheels,

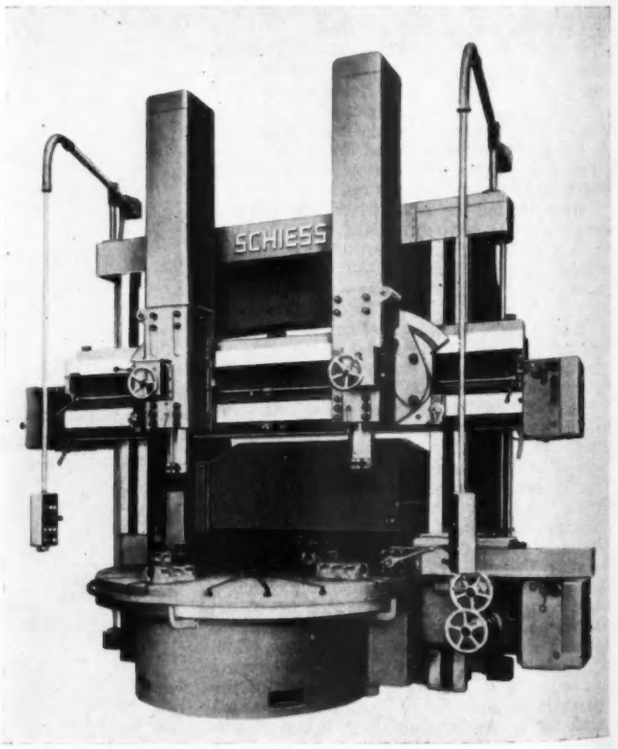


Fig. 9—Double column vertical boring mill for work weighing up to 8 tons—Schiess

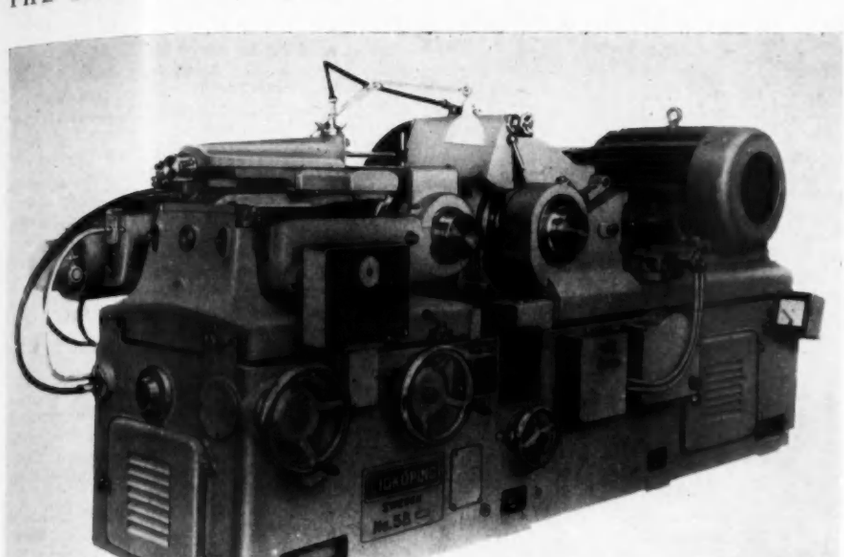


Fig. 10—Centreless grinding machine for through-feed grinding work from 0·2in to 13in diameter or continuous grinding bars and tubes up to 8in diameter—Lidköping

are carried on spindles mounted in precision double-row roller bearings at each end. The 16in diameter control wheel can be driven at any speed between 16 and 80 r.p.m. during grinding and at 120 r.p.m. for truing purposes. Hand wheels graduated in increments of 0·0004in are used for setting purposes and during grinding a push-button control is operated to feed the grinding wheel head in increments of 0·00008in, 0·00016in, 0·00024in, or 0·00032in, or, if required, 0·0002in, 0·0004in, 0·0006in or 0·0008 in. in a coarser range. This push-button control can readily be connected to an auto-sizing attachment for automatic adjustment to the wheel head during production. Hydraulically operated wheel truing equipment is provided and the machine can be arranged for an automatic truing cycle if specified.

The smaller Lidköping machine shown is a prototype of a new "2C" grinder to be introduced next year. This precision centreless grinder is recommended for 0·004in to 0·75in work up to 4½in long with infeed grinding or for through feed grinding bars from 0·004in to 0·375in diameter. The machine incorporates a push-button feed mechanism by which the grinding wheel can be advanced or retracted in increments of 0·00002in.

An unusual and interesting machine arrangement at Brussels was the prototype capstan lathe incorporating electronic programming made by Weiler K.G. Werkzeugmaschinenfabrik, Herzogenaurach, Nurnberg, Germany. This capstan has been designed for the high-speed production of components up to 4in long from 1in bar stock and in addition to being suitable for normal short run work is intended for longer runs where it would not normally be economic to use an automatic. To this end its system of programming is designed to reduce setting times to a minimum and spindle speeds up to 8500 r.p.m. are available.

As can be seen in Fig. 11, the machine is fixed on the rear wall of a rigid stand in a completely unorthodox way at 90 deg. This arrangement not only gives quick and free access to the forwards facing turret and slides for setting purposes, but it has the additional advantage that a rigidly reinforced base can be used as it does not have to be gapped to clear the cuttings which fall freely clear down into a container forming the foot of the main stand. The base of this container forms a coolant tank, and it is provided with interchangeable mesh filters to facilitate the removal of swarf.

The electronic programming equipment, which is transistorised and incorporates only two valves, is enclosed in a cabinet built into one side of the stand. All the motors, feeds and spindle speeds are preset by pegs plugged into a programming panel during the initial setting up operations. The slide and turret are actuated by hydraulic cylinders and it is noticeable with the control equipment and hydraulic lines that but few connections are exposed and these are well clear of the working area. As a conventional front cross slide cannot be fitted, as it would interfere with the free fall of the cuttings, a double back slide has been developed for its usual duties.

The particularly clean lines of the new "Gallic" 16in high-speed precision lathe of Mondiale S.A., Belgium (Soag Machine Tools, Ltd., London), can be seen in Fig. 12. This machine, available with 40in and 60in between centres, has a centre height of 8in and is fitted with a 10 h.p. motor. A two-position clutch pedal enables the operator to make rapid speed and feed changes or halt the spindle instantaneously. Large graduated dials are provided for all motions and they include one for the direct reading of longitudinal saddle movements. Micrometer stops are fitted for both longitudinal and transverse feeds and a slipping clutch which permits safe working against the stops also acts as an overload safety device. Spindle speeds range from 40 to 200, or 28 to 1400 r.p.m., whilst forty-two feed rates are obtained through the gearbox.

To enable copying and subsequent thread cutting operations to be carried out in one setting on the copying lathes made by Maschinenfabrik Heid A.G., Vienna, Austria, a special

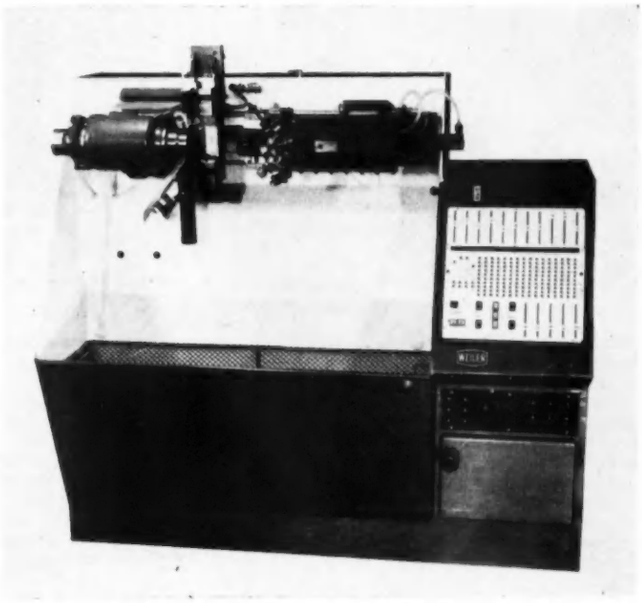


Fig. 11—Prototype capstan lathe with electronic programme control equipment —Weiler

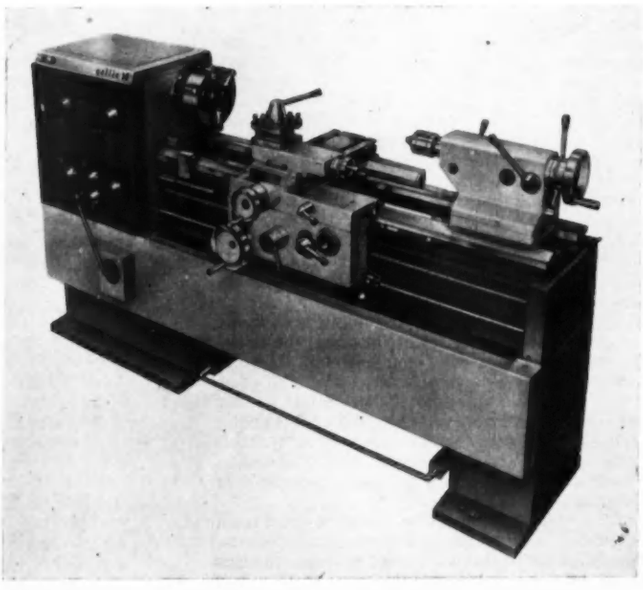


Fig. 12—High-speed precision lathe—Mondiale

CONTINENTAL AFFAIRS *(Continued)*

carrying structure was fixed to the rear shear of one of the firm's " DZK 400 " machines. A cylindrical guide bar fitted to this structure has adjustably mounted on it an automatic screw cutting attachment which enables short threads up to 1·97in to be cut at the high speeds permitted by carbide tools, and its work cycle, including tool approach and withdrawal, is fully automatic. The movements of the tool rest in the ratio of 3 to 1 when using a single-speed motor or four changes in the ratio of 6 to 1 with a two-speed, 15 h.p. to 35 h.p. motor. Through interchangeable gears the spindle speeds available range from 165 to 3090 r.p.m. All the carriage and slide movements are hydraulically actuated and the stepless feed range is from 0 to 47in per minute with quick traverse rates of 15ft to 18ft per minute. A cutting stroke of 5¾in. Thirty spindle speeds in two ranges of 40 to 834 or 60 to 1220 r.p.m. can be provided with three automatic speed changes and four feed changes per set-up.

With the " Discotrol " programme control unit the complete machining programme is prepared on a metal disc which is embossed by a detachable punch fitted on the machine during initial tooling-up. This punch makes raised dimple impressions coinciding with changes in speed, feed, position of turret and slides. These dimples in subsequent operation of the machine actuate micro-switches which signal the required change of operation, and each time a function is performed the setter is informed by the illumination of an indicator lamp on a panel adjacent to the micro-switch block.

A roll turning lathe of Forges, Usines et Fonderies de Gilly, S.A., Gilly, Belgium (Soag Machine Tools, Ltd., London), is designed for copy turning and swinging a maximum roll diameter of 21in, weighing up to 10 tons. This machine has a multi-tool box which can be precisely mounted to enable up to eight forms to be accurately positioned and simultaneously plunge-turned without reference to a master. For re-indexing the multi-tool box there is used a rack along the full length of the machine. Accurate initial turning of the roll can also be achieved by the plunge-cutting method, using the indexing rack and a 6in wide solid tungsten carbide tool of simple form. All feeds are power-operated through a Heid variable speed gearbox and can be varied during cutting by use of two plus or minus " inching " buttons.

The electromagnetic copying device fitted on the roll lathe functions with the same feed equipment and enables the rate of power feed to be regulated during cutting. This function is of advantage in that it enables the operator to change the feed rate for roughing and finishing, and also to vary the feed rate with the angle of approach of the tool. Copy plates of steel sheet can be made in short sections and fitted to the machine, various types of stylus to suit template form being supplied. A hydraulically loaded tailstock is fitted with a gauge for direct reading in tons and it compensates for expansion or contraction in the length of the workpiece.

Presses for cold forging steel components formed part of the range shown by Cold Forging, Ltd., Sunbury, Middlesex, and comprised two standard " Colforg " presses. One press was fitted with a combined tool for cropping and flattening and the other with a three-stage

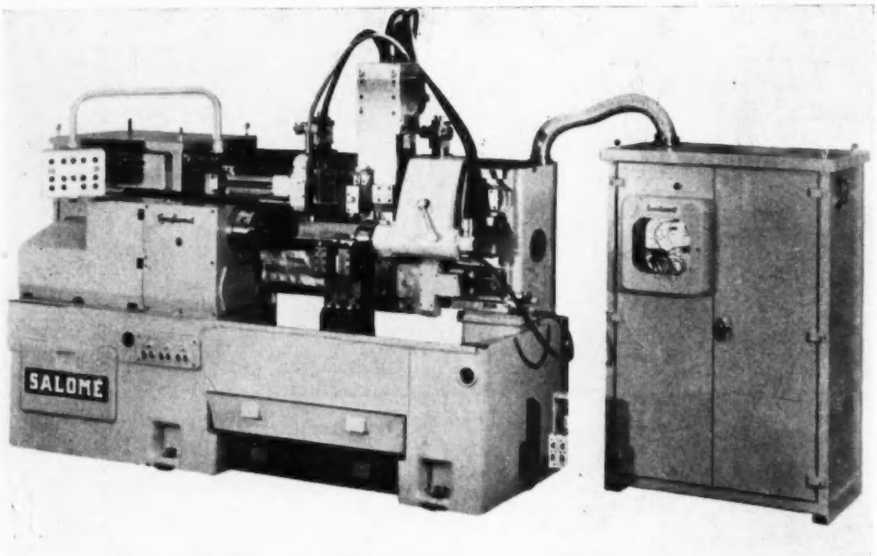


Fig. 13—Programme controlled automatic multi-tool and copying lathe—Salomé

are controlled by a cam which is coupled directly to an automatic tool lifting device. A selector unit allows pre-optive setting of the number of passes required for a given thread and gives control of the consecutive depths of cut, rendered progressively smaller as the thread is nearing completion.

A programme-controlled, automatic, multi-tool and copying lathe with a swing of just under 17in over the bed and available with distances between centres of 30in or 47in was shown by Salomé Frères, Nanterre, France (Dorman Machinery Sales, Ltd., Woodside Hill, Chalfont St. Peter, Bucks.). This " Synchromat " machine, in addition to copy-turning and boring operations, can be arranged for conventional turning, boring and facing work. As can be seen in Fig. 13, it has a vertical bed which has two sets of hardened and ground steel slideways on which are mounted carriage slides. Interchangeable transverse slide units can be fitted on the carriages. Two of these transverse slides can be fitted on each carriage and, alternatively, a copying slide can be fitted to the upper carriage in combination with a transverse slide unit, thus providing one copying and three transverse slides for one series of machining operations. Copying slides in single- two- and multi-pass types are available, the multi-pass design providing for four roughing cuts and two profiling cuts from the master template.

All the automatic rapid and fine feed motions of the carriages, transverse slides and the copying unit, together with chucking and tailstock operations, are hydraulically actuated and controlled by a plug-board according to the preselected programme sequence. Automatic spindle speed changes during the cycle are also programmed, and the slides may be operated in combined or successive sequences according to a preselected cycle.

The headstock has a direct-coupled drive from the motor and, hrough electromagnetic clutches, there are two automatic spindle speed changes

tailstock fitted on the upper bed slideway is hydraulically operated under push-button or programme control.

The " No. 95 " all-electric single spindle automatic chucking machine of B.S.A. Tools, Ltd., Birmingham, which we illustrate in Fig. 14 is fitted with the " Discotrol " programme control unit and, it incorporates electromagnetic clutches in the headstock and feed box. This machine swings work up to 12½in diameter under the bracket and 10½in over its cross slides, the turret having a total stroke of 8 $\frac{7}{16}$ in with a

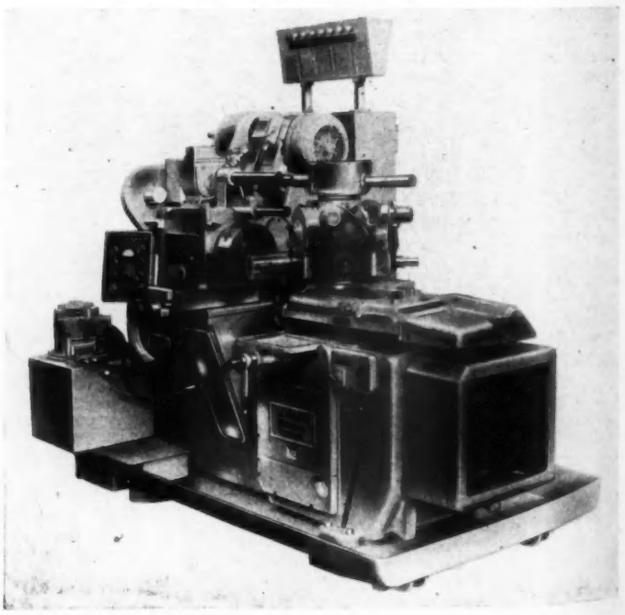


Fig. 14—All-electric single spindle automatic chucking machine, with the " Discotrol " programme control unit—B.S.A.

multiple tool for the actual forging operations. These two tools have been designed as complete self-contained units. The cropping-flattening tool is mounted on a common baseplate together with the bar feeder and the transfer mechanism for feeding the cropped parts to the flattening station. The three-stage forging tool is an in-line arrangement of three individual cold forging tools and it includes the necessary transfer mechanisms. The punch plate and die-bolster are connected by dowel-bars so that the tool can be assembled and adjusted in the toolroom before being fitted to the press as a complete unit. At the exhibition the tool was shown producing needle bearing cups. Although on the exhibition stand two separate presses were used to demonstrate the tools they are designed to be used alternately on the same press.

The range of deep hole drilling machines made by the Swiss Industrial Company, Neuhausen Rhine Falls, Switzerland, has been developed as a series of standardised models which are designed for operation with either a rotating drill or a rotating workpiece. The standard single spindle machine has a 7·3 h.p. motor driving the main spindle through interchangeable vee-belt pulleys at up to 6000 r.p.m. It is suitable for drilling holes up to 0·787in diameter to a depth of 19·685in and swings work up to 10½in diameter. A hydro-mechanical feed drive to the table slide gives a stepless range of rates from 0·787in to 7·874 in per minute and rapid traverse in both directions of 100in per minute.

A typical "S.I.G." three-spindle machine of the new range can be seen in Fig. 15. It takes three drills up to 0·472in diameter and drills holes to a depth of 9·874in. All machines in the range are push-button operated or follow an automatic cycle controlled by a timer. An automatic cycle starts with the advance of the drill bush assembly, pressing it against the workpieces. When the drills have advanced to the desired depth in the work the coolant flow and spindles are stopped and the drills returned to their starting position, at fast traverse rate, whilst the drill bushes retract. If required a workpiece magazine and transfer devices can be provided to give a fully automatic machine.

The "S.I.G." "HRF 500" cam milling machine is now available with a very useful range of attachments. This machine is suitable for machining cams and curved parts of 23in to 31in diameter and cylindrical cams of 10in to 13·780in diameter and 11in to 15·748in high. Attachments can be fitted for machining cylindrical cams with or without offset using simple flat sheet metal templates. A multi-turn milling equipment allows the machining of worms with constant or variable pitch, and two forms of grinding equipment are provided. What is termed an "oscillating" grinding attachment is used for ordinary one-side cams and grooved cams are handled by a "planetary" grinding equipment.

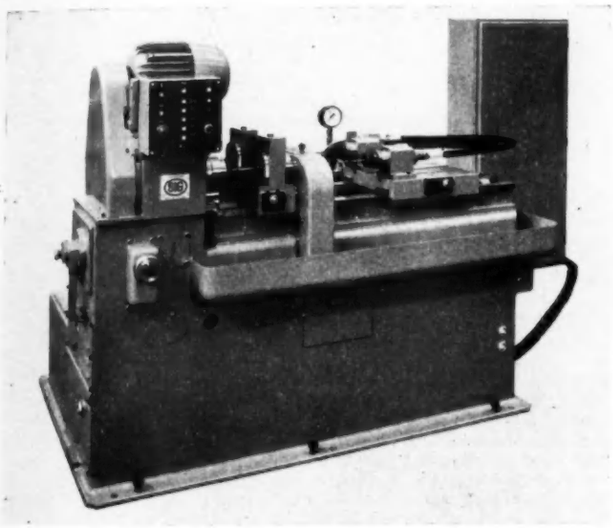


Fig. 15—Three spindle deep hole drilling machine, arranged for push-button or automatic cycle operation—Swiss Industrial

Shiplift at Henrichenburg

As part of the expansion of the Dortmund–Ems Canal, a shiplift is being constructed at Henrichenburg near Datteln. The lift, which is to be commissioned next year, uses a trough supported on floats, a principle adopted already for an earlier shiplift at the same site, as well as for the Magdeburg–Rothensee shiplift on the Mittelland Canal (1938). *The new lift will bring the number of installations at Henrichenburg to three—there is also a lock—and will add* 15,000,000 *tonnes to the total annual sluicing capacity, which for the remaining service life of the old shiplift will stand at* 33,000,000 *tonnes. The following article describes the new shiplift as well as referring briefly to the older installations.*

IN the north-western part of the German Federal Republic the large navigable rivers—Rhine, Elbe, Weser, Ems—are interconnected and extended by canals, to form an important system of waterways between the major industrial centres and the North Sea ports (Fig. 1).

One of these waterways is the 250km long Dortmund–Ems Canal which connects the Ruhr district around Dortmund with the sea at Emden. Opened in 1899 for ships of 600 to 700 tonnes displacement, the canal in 1901 already carried a traffic of 6·5 million tonnes. In 1914, a westward connection was made to the Rhine (the Rhine–Herne Canal), duplicated in 1930 when the Wesel–Datteln Canal, suitable for 1350-tonne ships, was commissioned.

In the midst of World War I, in 1916, the first stage of the Mittelland (Central) Canal was put into service. This joined the Ems Canal with the River Weser. In 1938 the connection eastward to Hanover and Magdeburg and hence to Berlin was completed. The junction with the Brandenburg and Central German Waterways is effected to the east of Magdeburg by way of the River Elbe. Installations include an important shiplift at Magdeburg–Rothensee, commissioned in 1938. Plans to cross the Elbe by a canal bridge and a double shiplift at Magdeburg–Hohenwarthe had to be shelved due to the outbreak of World War II. This direct connection would have rendered the navigation independent of changes in water level in the Elbe.

As far as design is concerned, the Magdeburg–Rothensee shiplift may be considered the prototype of the one now under construction. Built for ships with a capacity of 1000 tonnes, its trough also rests on two floats which are 36m long and have a diameter of 10m. The trough holds 2700 tonnes of water and has a useful length of 85m, a clear width of 12m and a water depth of 2·5±0·07m. The lifting height, nominally 15m, varies between 10·48 and 18·67m depending on the water level in the river Elbe.

It may be recalled here that Magdeburg–Rothensee was preceded by another shiplift, Niederfinow on the descent of the Hohenzollern Canal towards the Oder. At Niederfinow (1928–1934) a single 36m high lift paralleled four existing lock stages. The weight of the trough and water, together 4300 tonnes, was counterbalanced by 192 weights suspended from ropes.

After the war, traffic at Henrichenburg, which in the peak year 1938 had attained almost 12,000,000 tonnes displacement, rapidly began to recover from its decline to 5·7 million tonnes in 1944 and a few hundred thousand tonnes in 1945. Already in 1952, shipping surpassed the 10,000,000 tonne mark, and in 1959 exceeded 14,000,000 tonnes. On April 1 of that year, the canal was opened to 1000-tonne ships with a draught of up to 2·5m, and plans for its enlargement to take 2000-tonne vessels are said to be under consideration.

The key section is undoubtedly the length from Dortmund to Datteln where the Dortmund–Ems Canal joins the Rhine–Herne and Weser–Datteln Canals. In 1957, out of a total traffic of 26·7 million tonnes in the western section, between Herne and Münster, 12·9 million tonnes (24,000 vessels) travelled to and from Dortmund. Cargoes totalled 5·8 million tonnes in 1957 and 6·5 million tonnes in 1959. Seventy-two per cent of this traffic volume—mostly ore, gravel, and sand—was towards Dortmund, the principal outward cargoes being iron, steel, and coal.

The Dortmund–Datteln Canal is 14m higher in level than the adjoining section. Two factors add materially to the cost of maintenance and operation. The area forms part of the Ruhr coalfield and mining will continue for many years. The resulting subsidence has in the past necessitated the expenditure of large sums for heightening the canal banks and has rendered the mining companies liable for substantial indemnities. An agreement has therefore been concluded to co-ordinate operations so as to achieve a more uniform lowering of the land along the canal. The other factor is the absence of a natural inflow into the Dortmund reach. Consequently all losses, whether by evaporation, seepage, or through locks, have to be made good by pumping. The conservation of water is therefore of great importance economically.

First Shiplift

It was for that reason that the original shiplift (Fig. 3) was constructed in the years 1894–99. Its trough has a useful length of 68m, a width of 8·6m and a normal water depth of 2·5m. The maximum filling is 1550 tonnes. The trough is supported on five floats of 620 cubic metres each, which move in 27·5m deep shafts of 9·2m diameter, lined with cast iron tubbings.

Four 29m-high towers guide the lift up or down. Each is equipped with a 26·4m-long screw spindle weighing 9 tonnes, and operating in a stationary nut. The towers are anchored at a depth of 11m in the underlying rocky marl, so as to resist buoyancy forces which would arise if the water escaped from the trough. The screw spindles are driven by a common 150 h.p., d.c. motor situated on a bridge structure above the trough centre, the drive being taken from the motor to the spindles through shafts. The spindles, which are hollow, are equipped with a rectangular thread and are not self-locking so that a brake is required on the drive shaft. The

CONTINENTAL AFFAIRS *(Continued)*

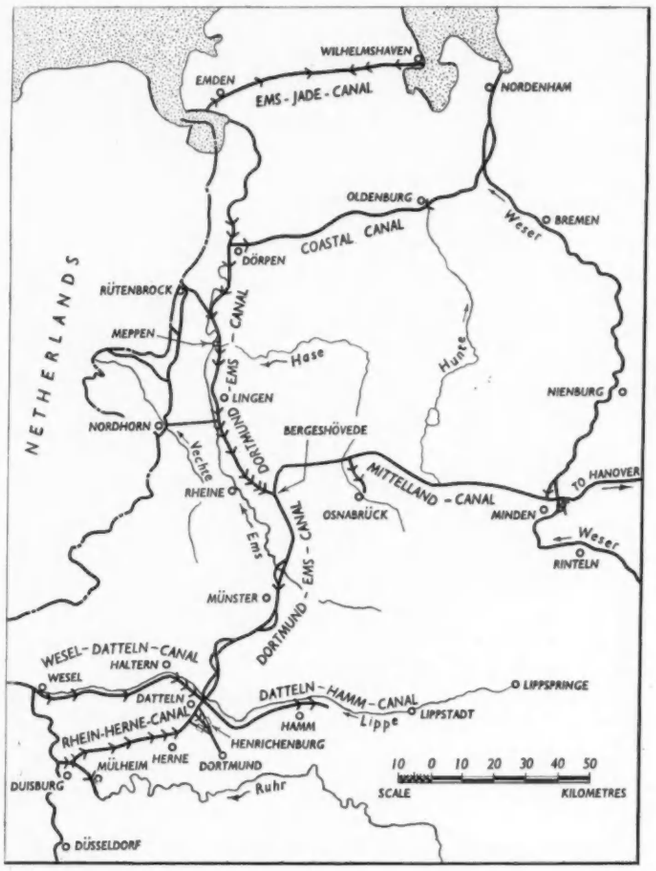


Fig. 1—West German inland waterways between Rhine and Weser

ends of the trough and the crown and tail canal are closed by counterbalanced vertical lift gates. For operation, each pair of gates is locked together. The drives are situated on the gate portals.

The speed of the lift amounts to 6·66m per minute and that of the gates to 7m in fifteen seconds. A complete up-and-down cycle, including entry and exit of ships, occupies forty-five minutes. The data are summarised in Table I.

TABLE I.—*First Shiplift at Henrichenburg*

Construction period	1894–99
Lifting height	14m (maximum 16m)
Annual capacity (displacement) ...	9·7 million tonnes
Maximum displacement of ships...	600 to 700 tonnes
Maximum draught	2m
Trough	68m by 8·6m by 2·65m*
Design water load	1550 tonnes
Steel weight, trough and supports	800 tonnes
Steel weight, floats...	600 tonnes
Number of floats	five
Length of float	12·88m
Length, excluding spherical ends...	10·3m
Float volume, each	620 cubic metres
Total steel weight	2400 tonnes

* Depth of water (lifting) 2·50m : depth of water (lowering) 2·52m. When lowering, the depth is increased to compensate for the buoyancy of the submerged parts of the supports.

In normal as well as emergency conditions—emptying of the trough, or flooding of one or two floats—the spindles are subject to tension only, and are not designed to withstand a heavy thrust force.

This limits the capacity of the trough to ships of 2m draught, i.e. 600 to 700 tons, irrespective of the draught available in the canal itself. Based on 313 days of operation, each of sixteen hours, and taking into account shut-down periods due to ice, as well as closure or short-time working on Sundays and public holidays, the lift has an annual capacity of 9·7 million tonnes displacement. Since its commissioning, this shiplift has carried out approximately 500,000 working cycles.

Lock

Within a few years of the opening of the canal it was decided to supplement the shiplift with a lock as a standby. Between 1908 and 1917, therefore, a deep lock was constructed in parallel with the shiplift, negotiating the 14m difference in level in a single stage. Its chamber has a useful length of 95m and a width of 10m, and a water depth over the sill of 3m (at 1899 canal level). Ships of 1500 tonnes with a draught of 2·5m are able to use the lock.

The lock is constructed in reinforced concrete with a mitre crown gate and vertical lift tail gate, and cylinder filling valves. A detail of major importance is the provision of economiser reservoirs totalling 9850 square metres in area. These are grouped in five pairs, with differences in level of 2·11m between successive pairs. The complete working cycle takes sixty minutes and the annual capacity, under the same conditions as for the shiplift, is 8·35 million displacement tonnes. The installation includes a pumping station with two sets, each of 1·5 cubic metres per second capacity.

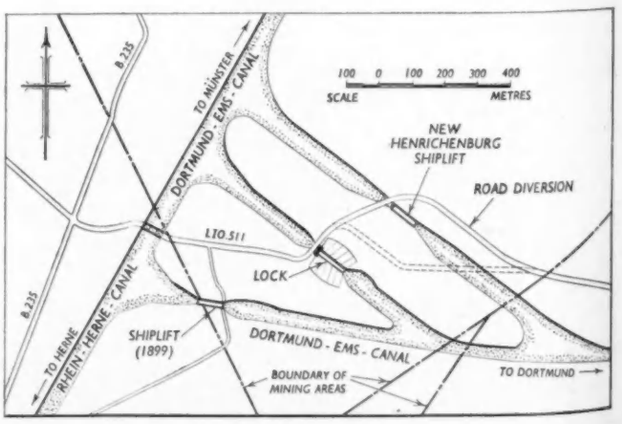


Fig. 2—Fall of Dortmund-Ems canal, Henrichenburg

New Shiplift

Plans for the present third stage at Henrichenburg go back to 1922 when the need was first recognised to expand the canal system for a draught of 2·5m and ships of 1000 to 1500 tonnes. These expansion plans, which included the extension of the Mittelland Canal, and the creation of the Hansa Canal, were further formulated in 1928 in respect to the Dortmund–Ems Canal and the third Henrichenburg stage. Work along the canal was begun in the years preceding the war, but this, as well as studies and preliminary work in connection with Henrichenburg, were shelved in 1941. The project was resumed in 1955.

One of the principal motives in building the Henrichenburg lock was undoubtedly to have a standby in case of a failure of the shiplift. The cost of the shiplift has been 2·6 million marks, plus 200,000 marks for its pumping station which was discontinued when the lock pumping station came into use. The lock required an outlay of 1·86 million marks, and its pumping plant a further 165,000 marks.

The decision to build the third stage eventually became urgent because of the insufficient capacity, in particular for the daily peak traffic, of the old installations, and the fact that the useful life of the earlier shiplift is coming to an end. Moreover, whereas mining operations in the next fifteen years will lower the Dortmund Canal section by 1·55m, and thereafter at the rate of about 0·1m per annum, there are no workable coal deposits at Henrichenburg itself, so that the old structures (which in any case were not built to withstand subsidence unscathed) would be left standing high and dry unless costly and time-consuming alterations were carried out.

Various configurations both of locks and of shiplifts were studied. As the most suitable form of lock, a concrete structure was determined with four economiser reservoirs in the form of circular sectors arranged on either side. The rate of rise was to have exceeded 3m per minute.

Investigation showed that a lock for the third stage would be cheaper to build than a shiplift, and also cheaper to maintain, but that operating costs would be much heavier. With a water loss of 5000 cubic metres per working cycle, even with a cheap night tariff, electricity charges for pumping would amount to DM.180,000 to DM200,000 per annum. Finally the tonnage capacity of the lift would be nearly a quarter higher.

The decision therefore fell in favour of the shiplift. Fig. 2 shows a sketch map of the site. The subsoil in the chosen situation is rocky marl which is watertight and permitted the shafts for the floats to be sunk in the dry. Care was taken to establish the absence of geological faults so as to make it likely that any settlement would proceed evenly over the whole area.

A design with two floats was decided upon embodying the experience gained with the old shiplift as well as with Magdeburg–Rothensee.

Fig. 4 shows an elevation. The principal data will be seen in Table II.

TABLE II.—*New Shiplift at Henrichenburg*

Construction (scheduled)	1958–62
Lift at commissioning	13·75m*
Trough :	
Useful length of trough	90m
Width of trough...	12m
Height of trough	approx. 3·5m
Depth of water in trough	3m ± 0·1m (for up and down movement)
Steel weight of trough including supports	870 tonnes
Water filling	3500 tonnes (approx.)
Floats :	
Number of floats	two
Outer diameter	10m
Height, including ends	35·25m
Displacement, each	2500 cubic metres
Weight, each	315 tonnes
Guides :	
Number of guide towers	four
Height (approx.)	21m
Number of screw spindles (one per tower)	four
Spindle length (approx.)	20·5m
Weight (approx.)	16 tonnes
Nut, length	1·45m
Bush, length...	0·83m
Drive :	
Number of d.c. motors (one per spindle)	Four
Horsepower per motor	150
Lift speed of trough	9m per minute
Lift speed of gates	0·25m per second

* Maximum decrease of 8m through mining subsidence of crown canal catered for by design.

The foundations form a watertight concrete trough of adequate mass to resist catastrophic lift forces such as would arise if the ships' trough were to run dry by accident.

Below the foundations have been sunk two shafts 52·48m deep for the floats. These have an internal diameter of 11·32m and are lined with 0·51m of brickwork and a 0·45m thick reinforced concrete lining constructed with sliding shuttering. The intermediate space of 0·25m thickness was filled with gravel (grain sizes from 50mm to 70mm) and injected with cement grouting. The bottom of the shafts is formed by a reinforced concrete slab 2·3m thick at the centre and 1·5m thick at the sides.

There are four guide towers arranged in two pairs on either side of the ships' trough. The guides stand approximately 21m high and can be vertically aligned to allow for a tilting of the foundations up to 1 in 200. Each guide tower is equipped with one screw spindle. These are approximately 20·5m long and weigh 16 tonnes. They rotate in stationary nuts of 1·45m length fitted with 0·83m-long interchangeable bronze bushings and supported on rubber mountings. The spindles have a trapezoidal thread. They are always in tension and are self-locking under all normal and abnormal modes of operation, such as accidental emptying or flooding of the trough, and flooding of the floats.

Each spindle is individually driven by a 150 h.p. d.c. motor at the top. The motors will be supplied either by two Ward-Leonard sets or rectifiers. Synchronism will be maintained by connecting all four spindles by a common shaft running along a duct in the centre of the concrete base. In case of failure of one motor, the other three will be able to drive its spindle through the synchronising shaft.

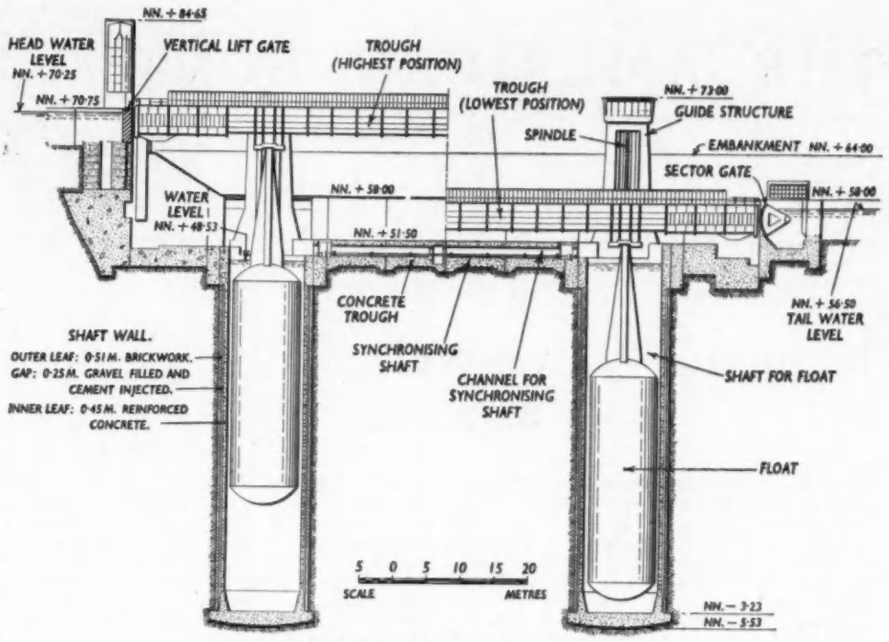


Fig. 4—Shiplift at Henrichenburg (under construction)

The ships' trough is a steel structure in the form of a "U"-section beam comprising a bottom plate and lateral plate girders, suitably stiffened by frames and longitudinal ribs. The ends of the trough are closed by sector gates. The trough rests by means of transverse girders and vertical supports on the two floats. The combined steel weight of trough and supports amounts to 870 tonnes.

The floats have a diameter of 10m and a height, including the domed ends, of 35·25m. Their combined weight is 630 tonnes and their displacement 2500 cubic metres each (approximately). They are subdivided into two compartments and a trimmer chamber for balancing the increase in buoyancy caused when the trough supports are being lowered into the water. In order to reduce the effect of the external water pressure, the floats are filled with compressed air.

The tail gate is a sector gate and the crown gate a vertical lift gate. All gates are individually driven. Watertight connection between the trough and the land gates is formed by means of "U"-shaped sealing frames which are hydraulically held against their seatings on the trough and against the land abutments.

The crown sill is built up of eight concrete slabs each 1m thick, so that it will be an easy matter to reduce the sill level to correspond with the anticipated lowering of the crown canal, simply by taking out the blocks in succession.

During the operation of the lift the total weight will be practically balanced by the buoyancy of the floats which will amount to approximately 5000 tonnes. A deviation of 10cm either way from the nominal water depth of 3m in the trough is permissible but any greater deviation in level will be nullified by pumping water in or out by means of immersion pumps installed in the landside gates.

The installation will include crown and tail bays 48m wide and 3m deep. The crown bay will have sheet-piled walls rammed into the impervious subsoil, while the tail bay will be given sloping banks.

A complete working cycle up and down of the lift, including entry and exit of ships, will be completed in thirty-four minutes. Under the conditions of 313 working days of sixteen hours per annum, allowing for short time and shutdown on Sundays and public holidays and for closure periods due to ice, the annual tonnage capacity is designed to be 15·1 million tonnes. The cost of the lift without waiting bays has been estimated at DM.24,000,000, and the bays another DM.14,000,000. Final operation may start this year, and commissioning is scheduled for 1962.

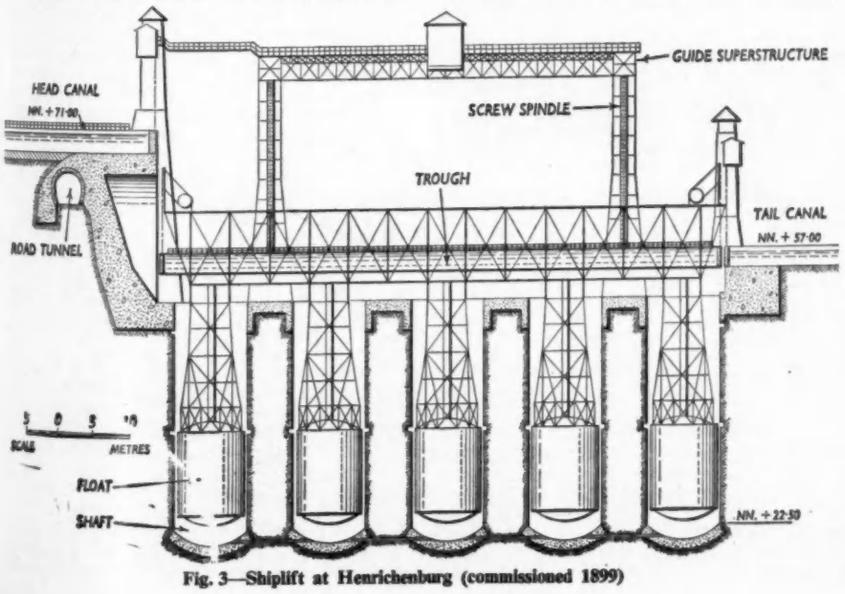


Fig. 3—Shiplift at Henrichenburg (commissioned 1899)

CONTRACTORS

Steel structures : working group comprising Rheinstahl Union Brückenbau A.G., Dortmund, together with Demag A.G., Duisburg ; Gutehoffnungshütte Sterkrade A.G., Oberhausen ; Aug. Klönne, Dortmund ; Fried. Krupp Maschinen- und Stahlbau Rheinhausen ; M.A.N. Werk Gustavsburg.

Sub-contractors for electrical equipment : Siemens-Schuckertwerke A.G., Berlin-Erlangen ; A.E.G. Allgemeine Elektricitätsgesellschaft, Berlin–Frankfurt/Main.

Civil engineering : working group comprising : Grün & Bilfinger A.G., Essen, together with Ph. Holzmann A.G., Bochum ; Polensky & Zöllner, Dortmund ; and the subcontractors : Deilmann Bergbau G.m.b.H., Bentheim (shaft sinkings) ; Johann Keller G.m.b.H., Frankfurt/Main (injections).

Waiting bays : Wilhelm Hirdes, Herne ; Baugesellschaft Hanebeck m.b.H., Dortmund.

Electronic Components Exhibition

The fourth International Exhibition of Electronic Components is to take place at the Porte de Versailles, Paris, during the period February 16 to 20, 1962. Full information may be obtained from the organisers : S.D.S.A., 23, rue de Lubeck, Paris, 16e.

THE AMERICAN SCENE

By Our American Editor

Numerically Controlled Tube Bending Machine

THE development of a numerically controlled tube bending machine with an integral tape writing and reading unit has been announced by the Nu-Era Corporation, of Rochester, Michigan. The so-called "Bend-O-Matic" machine (Fig. 1) can handle tubing of any material up to 1¼in diameter and up to 8ft long. Repeat-bending can be performed with absolute dimensional fidelity; the machine holds bend and twist angles to tolerances of plus or minus three minutes and linear dimensions to plus or minus 0·005in. The equipment has been developed particularly to meet a need by the aircraft and missile industry for accurate bent metal tubing to carry hydraulic fluids, fuels, lubricants, water, gases and air. The reduction in set-up time achieved with the new machine is of special importance in short-run production and replacement part manufacturing operations. A complete changeover from production of one bending pattern, tube diameter and radius to another can be made in thirty-five minutes average.

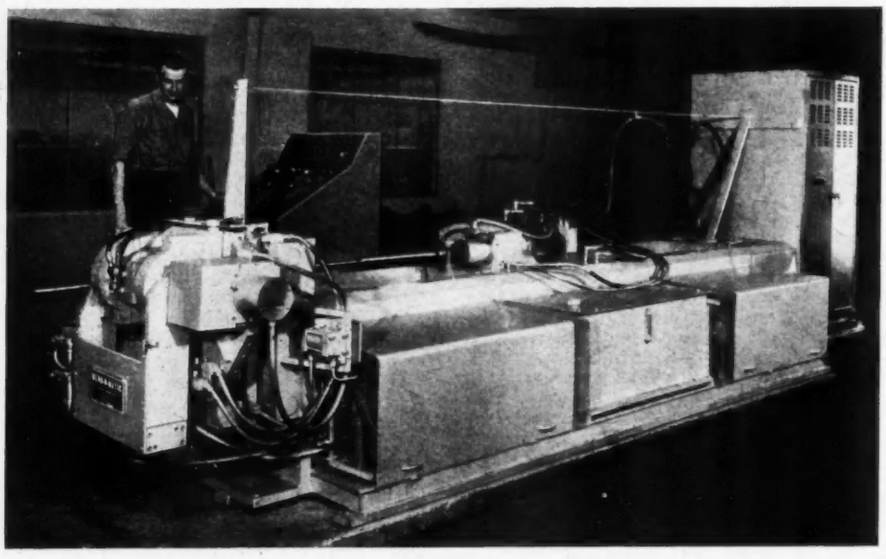


Fig. 1—"Bend-O-Matic" numerically controlled tube bending machine for handling up to 1¼in diameter tubing

Because the machine is numerically controlled, no inspection fixtures are required. Once a programme has been punched on tape, it can be used repeatedly to produce the same part to close dimensional tolerance. The tape can be stored in minimum space and put back into the machine at any time. The only set-up required when a new tube configuraton is to be produced is (1) the insertion of the punched tape in the reader unit; (2) the installation of the appropriate part clamp, wiper and shoe, radius block and mandrel to suit the tube diameter; and (3) the setting of the initial tube position with the floating zero arrangement provided on the numerical positioning control console. The first part produced following this brief set-up procedure will be identical with the last part produced prior to the removal of the tape for storage.

Basically, the machine consists of a bending unit with controlled motions for advancing, twisting and bending the tube, and a General Electric Mark III numerical positioning system. Integral with the latter are decade push button, tape writer and tape reader equipment. In operation, the tube is manually inserted through the bending arm, over a mandrel and into the collet chuck. The "Collet Clamp" and "Cycle Start" buttons are depressed in turn, and the machine automatically carries out all tube-advance, twist and bend operations under numerical control on signal from the programme tape in the console. At the end of the cycle, the machine automatically unclamps the part on operator signal. The main slide then returns automatically to the "Cycle Start" position. The bending action is smooth and continuous; the complete bend is accomplished in a single motion. This kind of bending action avoids the introduction of surface stresses in the tube in the vicinity of the bend, thus eliminating a potential source of tube failure in service under load.

The "Bend-O-Matic" machine has three numerically controlled motions: the tube advance or feed, called the *X*-motion, which controls distance between bends; the actual bending of the tube, called the *Y*-motion, which controls the degree of bend; and the twisting of the tube, called the *Z*-motion, which controls the angular relationship between bends. The *X*-motion is accomplished by advancing the main slide at approximately 150in per minute with a servo motor-driven precision lead screw. An *X*-motion selsyn feed-back device driven by the lead-screw controls the position of the main slide within plus or minus 0·005in of the length-between-bends dimension punched into the tape.

The *Y*-motion is accomplished with a bending arm which is moved through a prescribed arc by a hydraulic rotary actuator. A *Y*-motion selsyn feedback controls the degree of bend. The *Y*-motion is accompanied by a hydraulic clamping action and a combination vertical and horizontal movement of the bending head. The tube is clamped before each bend by the part clamp which is moved into position by a hydraulic cylinder. The part clamp holds the tube firmly against the radius block during each bend. Following each *Y*-motion, the tube is unclamped, the radius blocks and clamps clear the work, the tube advances into position for the next bend, and the blocks return to bend position. The radius block is mounted on an overhung shaft so as to simplify change-over from one tube size to the next. With this arrangement the bulky shaft support member could interfere with the tube in a situation where the length between bends was short and where twist of the tube would bring the previously bent length in an arc toward the bending arm. To prevent such interference, the bending head (Fig. 2) is designed to move vertically and horizontally to clear the arm. Upon completion of the bending motion, the tube is unclamped and the entire bending head is moved out of the way by the horizontal and vertical motion cylinders. After the tube has been advanced and twisted, the bending head is moved horizontally and vertically back into position, and the part clamp is moved up into contact with the tube ready for the next bend.

The *Z*-motion is accomplished through a servo motor drive. A *Z*-motion feedback selsyn controls the degree of twist. Tube collapse during bending is prevented in the machine by a properly sized mandrel that provides internal support for the tube during each bend and is extracted automatically. The mandrel is secured to a hydraulic control cylinder, which is fixed to the machine base. It passes through the hollow shaft of the auxiliary slide hydraulic cylinder and the hollow collet spindle.

In operation, the main slide advances in carrying out the *X*-motion, carrying with it the auxiliary slide with its advance and return cylinder and the collet. Since the tube is firmly clamped between the radius block and the part clamp, the natural effect of the bending action is to pull the remaining straight length of tube forward. This motion is permitted through the auxiliary slide which moves forward under controlled resistance from its hydraulic cylinder. Simultaneously with the clamping of the tube between the radius block and part clamp, the mandrel control cylinder advances the end of the mandrel to its proper position directly below the centre of the radius block. It remains there until the bend is completed, at which time the mandrel is retracted to the zero position.

The machine operator develops a bending programme with the decade push buttons on the console when a part is being produced for the first time. When the machine cycle button is depressed during manual operation, the tape is created automatically while the part is bent. This is an innovation which saves time, simplifies programming and solves a problem that has long been present in the production of tubes having multiple complex bends. Because a fluid-carrying tube in a complex system must be

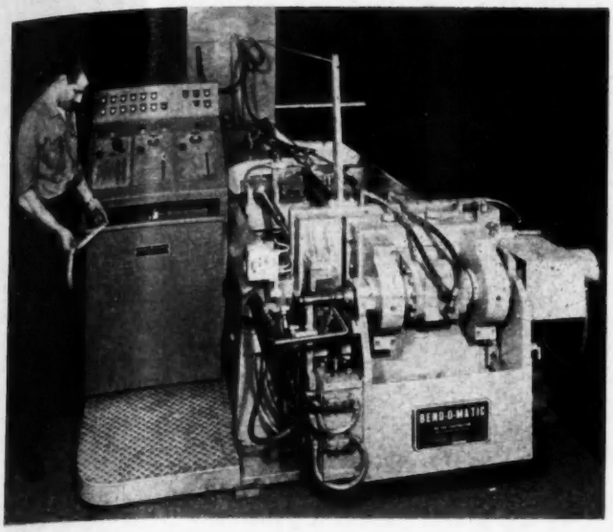


Fig. 2—Bending head with controlled motions for advancing, twisting and bending of the tube, and General Electric tape control unit at left

formed and bent to clear objects of various sizes and shapes, it is practically impossible to produce an engineering drawing that can be properly interpreted in terms of a finished part. Most bent tube parts are produced in prototype form on a bend-as-you-go basis.

The operator first uses a measured length of stiff wire or soft tube which he deforms, using flat bends as required, to connect two terminal points in a hydraulic, liquid oxygen, lubrication or fuel system. When he is satisfied that the tube is properly bent, he proceeds to produce a tube of the same configuration. A tube of the right length is inserted in the "Bend-O-Matic." The operator measures and computes the effective length from the tube. This information is punched into the first bank (*X*-motion) of decade buttons where it is automatically stored until ready for use. Using a protractor and applying known laws of tube springback for the material he is working with, the operator measures and computes the effective angle of the first bend. This information is punched into the second bank of decade buttons (*Y*-motion) and stored there. The third bank of decade buttons, which relates to degree of twist (*Z*-motion), is not required for the first bend.

With the console set for manual operation, the operator depresses the "Cycle Start" button, causing the machine to feed the tube forward and bend it by the indicated amount. When the cycle for the first bend has been completed, a light indicating "In Position" will come on. At this point, the operator depresses the "Punch Tape" button and the decade information is automatically transferred from storage and punched by the writer unit on a paper tape. The process is repeated for the second and all subsequent bends. When the prototype tube has been thus produced, it is checked against the actual assembly into which it is to be installed. Any required alterations are noted and a new tape is produced simultaneously with a prototype part.

Because of the extreme accuracy of the machine, such cut and check operations are held to an absolute minimum. Once a prototype tube of proper configuration has been produced, there is no question of machine set-up to reproduce it. The machine is already adjusted; as soon as the operator inserts the tape in the reader unit, production can begin. Every tube produced from the tape will be identical with the accepted prototype tube.

In a production cycle sequence, the collet chuck grips the tube end as the tape reader reads the first block of information. The first programmed block includes degree of bend and start position for length feed and tube rotation motions. Next, the part clamp, wiper shoe and mandrel are advanced. Limit switches indicate clamp and mandrel advance are set, and bending motion begins. The mandrel is retracted when the "bend complete" signal is read. The part clamp and wiper shoe retract upon the signal being read. "Clamp retracted" signals the auxiliary slide to advance about half the diameter of the tube.

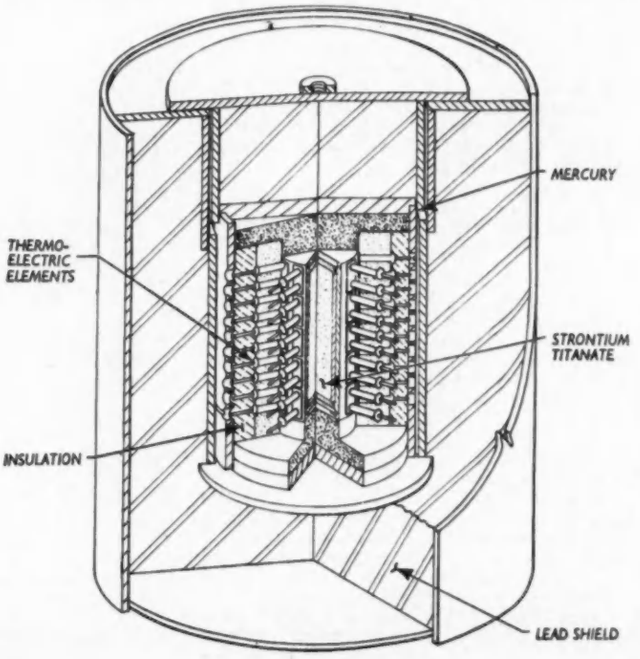
Upon signal, the bending head lowers to clear the pipe. "Bending head down" instructs the bender to return to zero position. The tape reader now reads the next block of information after the bend is complete and before the bend motion reaches zero. "Bend motion at zero" signals the length feed and pipe rotation for the next bend. The bending head is raised to the bend position and the basic cycle is repeated. After the final bend, the bend motion returns to zero and the machine stops. The operator can now remove the finished tube by opening the collet chuck and releasing for tube removal. Using a continuous tape for repeat production, "chuck open" signals the main slide and tube rotation motions to return to start position. The machine is now ready to receive a new part and the sequence will repeat indefinitely.

The numerically controlled bending machine can handle tubes up to 1¼in diameter and up to 8ft long. Its bending range is from zero to 189 deg., depending on the tooling. It has a 3in maximum bending radius. Hydraulic power is supplied by a 10 g.p.m. pump, operating at 1000 lb per square inch maximum and driven by a 7½ h.p. motor, and two 5 g.p.m. pumps operating at 1000 lb per square inch maximum and driven by a 7½ h.p. motor. The maximum bending torque of the machine is 13,200 in-lb at 1000 lb per square inch system pressure. The complete machine, including the numerical positioning control and the numerical operating console, requires 8ft by 22ft of floor space.

Automatic Weather Station for Canadian Arctic

AN isotope-powered, automatic weather station is about to go into operation in the Canadian Artic. A dream of meteorologists for many years has been to obtain automatic weather observation from strategically located remote areas. Unfortunately, many of the desired locations are relatively inaccessible, and to establish manned stations would present such problems as recruiting an isolation staff and maintaining supply operations. An automatic weather station, capable of functioning unattended for up to two years, has now been developed. Earlier difficulties, which were created by lack of a continuous power source, have been eliminated by the use of isotope power. The U.S. Atomic Energy Commission and the U.S. Weather Bureau jointly worked on the design and fabrication of equipment to provide reliability consistent with the long life of the isotope, to use a minimum of electrical energy and to provide accurate weather data in usable form. The close co-operation maintained between the U.S. Weather Bureau and the Canadian Department of Transport prompted the latter's Meteorological Service to suggest that the station be installed for trial and operational use in the Canadian Arctic. As a result, it will be located on the remote, uninhabited Graham Island in the vicinity of Norwegian Bay, about midway between the Canadian weather stations at Eureka and Resolute.

The station and power source are housed in a cylindrical, insulated container, approximately 8ft long. The lower 5ft will be buried in the permanently frozen ground. Reliable and rugged meteorological instruments mounted as integral parts of the station will measure wind direction and speed, temperature and barometric pressure. These readings will be fed into a data processing system and will emerge ready



Cutaway view of weather station power source employing strontium titanate fuel

THE AMERICAN SCENE *(continued)*

to go directly into the transmitter, which in turn will relay them every three hours to the receiving stations at Resolute and Alert. The anemometer and thermometer will be exposed on a tower beside the station, while the barometer will be placed within the cylinder along with recording equipment, wireless transmitters, aerials and other electrical apparatus.

One of the unique features of the station is the power source, shown in the accompanying drawing, which is situated in a lower chamber of the container. Consisting of a strontium-90 heat generator and thermocouples, batteries, and a converter, it uses an insoluble chemical form of the isotope strontium-90 securely locked in a corrosion resistant capsule and shielded by three-quarters of a ton of lead. The excess heat from the strontium-90 is used to maintain an interior operating temperature of approximately 70 deg. Fah. This element produces thermal energy which, when converted into electricity, charges the nickel-cadmium storage battery system, which, in turn, activates the transmitter. The isotope strontium-90 has a relatively long half-life and is capable of producing usable power for over ten years. The compound used, strontium titanate, is insoluble and biologically inert, with a melting point so high that it could not be dispersed by the hottest petrol fires.

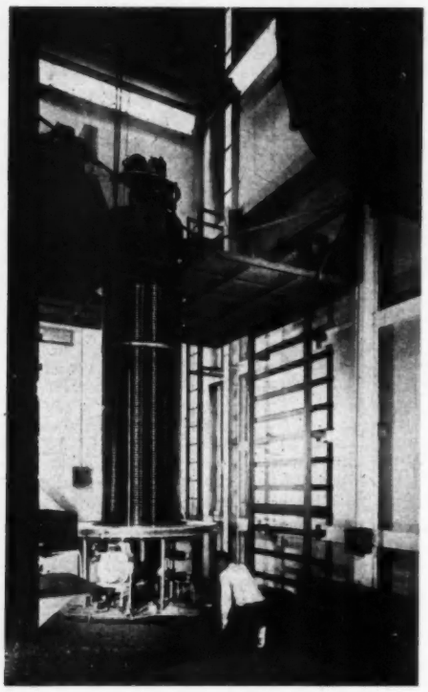
The thermo-electric assembly consists of sixty pairs of lead telluride elements arranged like spokes around the cylinderical heat source. The elements, like the electronic components, were built by The Martin Company, of Baltimore, Maryland. They are connected in series to a single outlet. The actual fuelling of the generator was carried out by the Oak Ridge National Laboratory in Tennessee, but earlier the generator has been checked out with an electrical heater simulating the fuel capsule. Under these conditions the converter operated continuously for about 6000 hours without any decrease in efficiency or output. The principle of thermo-electric conversion has been recognised since early in the nineteenth century, but its widespread use has developed only recently due to improved efficiencies offered by semiconductor materials. When two dissimilar metals are joined in a closed circuit and the two junctions are kept at different temperatures, an electrical current is produced within the circuit.

The fuel compound selected by Martin and the A.E.C. was strontium titanate, which remains stable even beyond its melting point of 3000 deg. Fah. Its rate of solubility in fresh-water is so low that it has never been measured, and even in sea-water its solubility is measured in parts per billions. In the operating generator, the fuel pellets are encased in several layers of the cobalt-base alloy Hastelloy-C, which has been under study by the U.S. Navy for well over a decade. It would take centuries to corrode, even if immersed in the ocean.

Accelerator for Nuclear Physics in South Africa

The High Voltage Engineering Corporation, of Burlington, Massachusetts, has announced the sale of a 5·5 MeV nuclear physics research accelerator to the Southern Universities Nuclear Institute in the Republic of South Africa. The large Van de Graaff machine will be installed at a new institute operated jointly by the University of Stellenbosch and the University of Cape Town. The accelerator will be financed primarily by the universities and local manufacturers, with a major contribution from the Republic. The machine will be used for nuclear structure investigation and will be equipped with a precise beam bending and analysing magnet which will direct stabilised protons into nuclear targets. A switching magnet will make it possible to conduct several experiments concurrently.

High Voltage Engineering has supplied chemical and physics research accelerators to over 150 universities and companies, but the accelerator purchased by the Southern Universities Nuclear Institute represents only the sixth machine for research south of the equator, and the first of its kind in the southern hemisphere. Orders for several more machines in Africa and South America are expected.



5·5MeV Van de Graaff particle accelerator for nuclear physics research during works erection

High-Speed Weighing of Rail Wagons in Motion

FAIRBANKS, MORSE AND CO., Yonkers, New York, U.S.A., has despatched from its works a large electronic weighing-in-motion machine for rail wagons. It is being installed in the new rolling mill now under construction for the Great Lakes Steel Corporation at River Rouge, Detroit, and is claimed to be the first weighing machine of its kind to be incorporated in the layout of a steelworks.

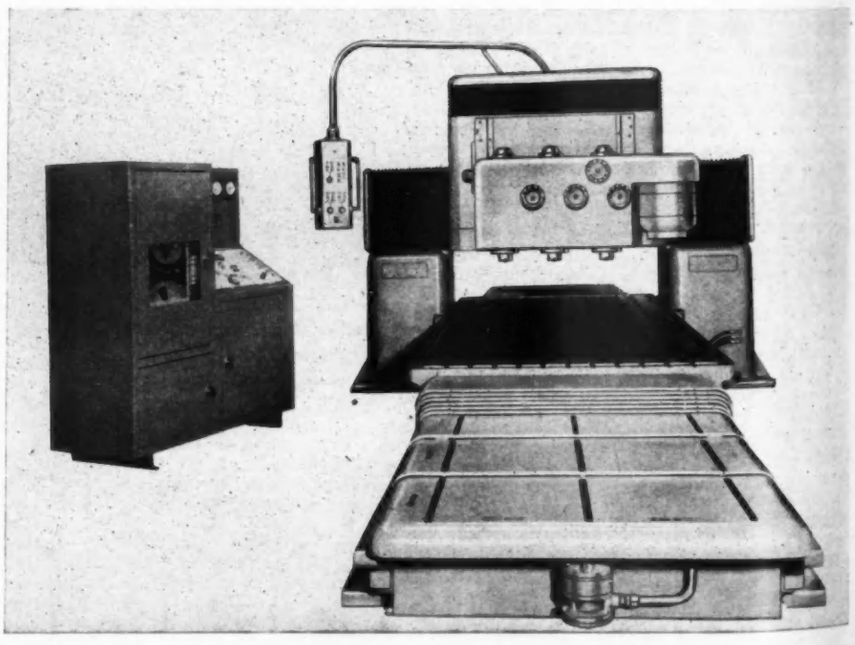
The machine, which has a weighing capacity of 330,000 lb, is based on an 80ft long mechanical lever track scale and is designed for two-directional weighing, the works layout being so arranged that all incoming and outgoing traffic can be weighed. Uncoupled freight cars are moved across the track scale, and the weighing operation takes about three seconds, the car remaining in motion while the weight is determined, fed into an adding machine and printed out.

A Fairbanks Morse electronic high-speed weigher is the basis of the recording system. It is operated by strain gauge load cells linked to the lever system. Bonded strain gauge load cells have a very high rate of response, and are highly sensitive to vibrations caused by flat spots on the wheels of moving cars. The machine makers have therefore had to develop lever-damping assemblies to reduce the transmission of vibrations to the load receiving element and to devise damping techniques to shut out unwanted signals from the electronic amplifiers.

Profiling and Milling Machine

We have received details of the Swiss "200" profiling and milling machines made by Ekstrom Carlson and Co., 1400, Railroad Avenue, Rockford, Illinois, for which the sole United Kingdom agent is Gaston E. Marbaix, Ltd., Devonshire House, Vicarage Crescent, London, S.W.11. Our illustration shows the three-spindle version, with three 10in diameter quills spaced at 14in between centres. Each spindle can be set and operated independently so that the machine can function as a single-, two- or three-spindle unit. The table measures 60in by 96in, and allows a clearance under the spindle nose of 4in to 14in (vertical slide movement) or 1in to 11in (quill extended).

The machine is operated either with manual push-button or punched or magnetic tape control. Longitudinal, transverse and vertical feed rates of from 0 to 150in per minute are available with tape control, and ¼in to 150in per minute with manual control. The counterbalanced spindle head is driven by a 60 h.p. motor.



Three-spindle milling machine with manual and tape control of horizontal, transverse and vertical movements. The spindle can be used in conjunction or independently

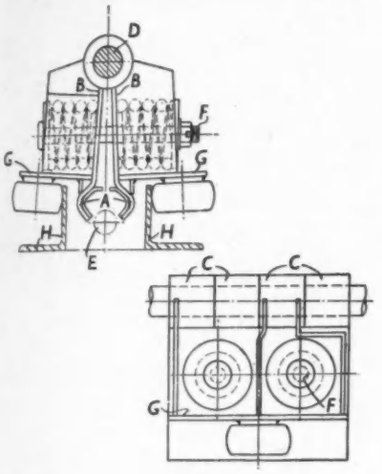
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

MINING EQUIPMENT

874,941. December 6, 1957.—HAULAGE CLIPS FOR RAILROAD VEHICLES, W. G. Allen and Sons (Tipton), Ltd., Princes End Works, Tipton, Staffordshire. (*Inventor : Howard Sidney Drew.*)

This invention has reference to haulage clips on the under part of mine cars, and consisting of movable jaws having means for closing them for coupling the vehicle to a power driven haulage rope moving lengthwise along the permanent way. The clip has means for engagement with a fixture arranged on the permanent way to effect the opening of the jaws. Each V-jaw *A* is provided at one end of an arm formed by a member *B*, which is similar to a hinge plate and has sleeves *C* respectively embracing a pivot pin *D* secured to angle brackets mounted on the framework of the mine car. The members *B* are free to pivot together on the pin so as to be able to move with the haulage rope *E* when it fails to maintain



No. 874,941

symmetrical position relative to the rails, or they can pivot independently of one another for opening the jaws. Each member *B* has a pair of aligned apertures carrying a bolt *F* having two compression springs respectively, mounted on it. The springs urge the members together to close the jaws. Each member *B* also has a platform *G* secured to it and each platform has a roller pivoted to its underside. The rollers are engageable with rails *H* between the rails at positions where it is desired to disconnect the mine car from the haulage rope. Each rail is bent in a generally horizontal plane to provide a lead-in surface, a jaw-opening surface, and a lead-out surface. In operation, the mine car is normally connected to the haulage rope *E* by being gripped between the jaws, the members *B* being urged together to grip the rope by the springs. When the car approaches the rails the rollers are contacted by the rails and are forced out opening the jaws from the engagement with the haulage rope. The mine car is reconnected to the haulage rope by moving beyond the rails to release the rollers and allow the jaws to grip the haulage rope.—*August* 16, 1961,

ENGINES

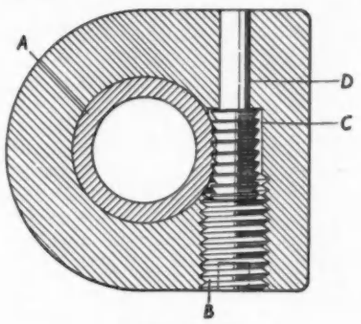
874,902. August 20, 1959.—POWER UNITS, Daimler-Benz Aktiengesellschaft, Stuttgart-Untertürkheim, Germany.

This invention relates to a power unit comprising an internal combustion piston engine and a gas turbine plant in which the output of both engines is coupled by a gear, the gas turbine being suitable for engaging and disengaging while the internal combustion engine is running. An object is to obtain an additional and substantial increase in motive power for the periods in which peak output is required, *i.e.* while the gas turbine is engaged, and with capital expenditure for both drives remaining practically unchanged or only slightly increased. The power unit comprises an internal combustion piston engine and a gas turbine each complete in itself and capable of operating independently the arrangement being such that with the gas turbine engaged its compressor supplies supercharging air for the internal combustion engine, the tapping-off of the pre-compressed supercharging air taking place either at the end of the compressor or at any suitable intermediate compressor stage. This arrangement offers the possibility of permitting the tapping off point for the supercharging air on the compressor to be moved to a higher or lower stage thereby varying the supercharging pressure, or adjusting the final supercharging pressure by admission control or control of the intake parts respectively. The arrangement can be such that the supercharging pressure is, for example, controlled in relation to the engine temperature, so as to prevent overloading (mainly thermal) of the piston engine during long periods of peak output. Details and drawings included in the specification show two examples of the power plant.—*August* 16, 1961.

SHAFTS

875,320. July 21, 1959.—FIXING SHAFTS INTO HOLES IN BODIES, The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2. (*Inventor : Sydney Hubbold.*)

This invention relates to a method of fixing a shaft to a body through which the shaft passes, and one particular application is to conduit for electrical wiring. One embodiment of the invention is described by way of example with reference to the accompanying drawing of a collar forming one of the cable entries of an iron-clad switch-box. Into a hole in this collar is fitted a tube *A* forming one conduit of the installation. The collar has a cotter way extending transverse to the axis of the hole the way having a first threaded portion *B* a second unthreaded portion *C* which cuts across the inner surface of the collar, and a third,



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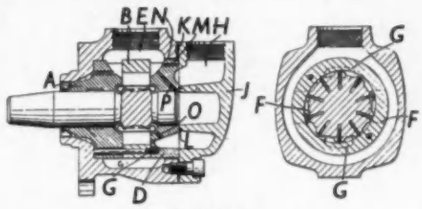
unthreaded, portion *D* of smaller diameter. Into this way there is screwed a cotter pin in the form of a socket-headed screw, approximately one-third of the length of which, nearest to the head, is threaded to mate with the first portion of the cotter way. The next portion of the screw is formed with a self-tapping thread which is of the same pitch and hand, but of smaller diameter than the first thread, and which has a slight taper towards the tip of the screw. The final portion of the screw provides a spigot which is a sliding fit within the third portion of the cotter way. When the cotter pin is screwed in the self-tapping thread engages the part of the outer surface of the tube which projects into the cotter way, cutting into it a corresponding thread. The spigot bearing in the farthest part of the cotter way provides an additional support against the transverse thrust exerted by the tube on the cotter pin. When the pin is screwed home the engagement of the self-tapping thread with the corresponding thread formed on the tube locks the tube firmly into position, the taper of this portion of the pin providing an additional wedging action.—*August* 16, 1961.

HYDRAULIC PUMPS AND MOTORS

875,950. January 7, 1958.—ROTARY VANE PUMP OR MOTOR, Heinz Teves, Ernst August Teves and Martin Tausend, trading as Alfred Teves Maschinen-und Armaturenfabrik K.G., 41-53, Rebstocker Strasse, Frankfurt/Main, Germany.

The invention relates to a rotary vane pump or motor provided with means for preventing the housing from being damaged by excessively high pressure stresses. Referring to the drawings, fastened between the pump housing and the cover are a suction disc *A*, a cam disc *B* and a delivery disc *D*. The medium to be pumped enters the top of the housing, flows around a suction chamber *E* surrounding the cam disc and passes through inlet slots *F*, *F* to the pumping chamber, whence it is forced through outlet slots *G*, *G* to a delivery chamber *H*. This construction of the suction chamber prevents the outside of the housing from being acted upon by the fluid under delivery pressure, which in some circumstances may lead to the housing being damaged. Situated between the



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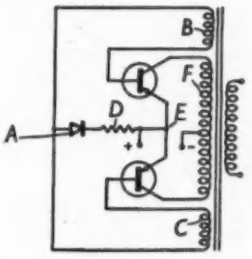
cover *J* and the housing is a packing disc *K*, and a packing *L* is provided between the cover and the delivery disc *D*. Elsewhere the cover bears directly against the delivery disc. If the delivery pressure rises to a value higher than the pre-tension of the cover screws, the cover lifts far enough away from the face of the delivery disc to permit the pumped medium to flow back from the delivery chamber *H* through axial bores *M* in the delivery disc or gaps *N* between the disc and housing, to the suction chamber. The packing disc *K* between the housing and cover ensures that the pressure medium is prevented from escaping from the housing. Fluid under pressure can pass to the bearings of the rotor shaft through a passage *O* in the delivery disc and excess fluid finding its way past the end of shaft is conveyed back to the suction chamber through a passage *P*.—*August* 23, 1961.

ELECTRONICS

874,995. December 23, 1958.—TRANSISTOR OSCILLATORS, Marconi's Wireless Telegraph Company, Ltd., Marconi House, Strand, London, W.C.2. (*Inventor : Alfred Conway Jones.*)

Of recent years the familiar type of vibrator unit for producing high-tension voltage from a low-voltage source has increasingly given way to apparatus in which high tension is produced by rectifying the oscillatory output from a transistor oscillator driven by a low voltage d.c. source. With a typical arrangement, as the load applied across the secondary coil increases from the open circuit condition, the overall efficiency of the oscillator increases up to a maximum



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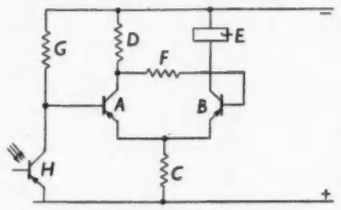
value which is maintained over a comparatively small range of loads and then decreases rapidly. If the load is increased enough, a point is reached where the oscillator will cease to oscillate, but there is a fairly wide range of loading between that corresponding to maximum efficiency and that at which oscillation ceases over which it is possible to damage the transistors by overheating. The decrease of efficiency occurring with increase of load is due to the transistors failing to " bottom " to their normal low collector voltage. Such failure results in an increase in collector dissipation in the " bottomed " state and overheating may result. A simple embodiment of the invention to prevent such damage is shown in the drawing. Its feature lies in the insertion of a rectifier *A* between the junction point of the coils *B* and *C* and the adjacent end of the resistance *D*. This rectifier is connected in such sense as to be conductive when the junction point is positive with respect to the point *E*. It will be seen, therefore, that if

the voltage at this junction point falls, the voltage across the rectifier *A* also falls and accordingly its resistance increases. This increase of resistance reduces the base current drawn by each transistor which causes further reduction of the voltage across the halves of the coil *F* so that a cumulative action sets in resulting in rapid switching off of the oscillations. The circuit is thus self-protecting. Two embodiments with an added self-starting circuit that does not prevent operation of the invention to protect the transistors. are shown in the specification.—*August* 16, 1961.

874,915. September 4, 1957.—PHOTO-SENSITIVE CIRCUITS EMPLOYING TRANSISTORS, Associated Electrical Industries, Ltd., 33, Grosvenor Place, London, S.W.1. (*Inventor : Robert Trevor Craxton.*)

This invention relates to photo-sensitive circuit arrangements for providing an indication as to whether light radiation is above or below a predetermined value, the circuit being small and cheap to manufacture. In the embodiment illustrated, a bistable trigger circuit is formed of two transistors *A* and *B* which have a common emitter resistor *C* and separate collector resistances provided by resistor *D* for transistor *A* and the operating coil of a relay *E* for transistor *B*. A connection is also provided between the collector of *A* and the base of *B* by resistor *F*. A d.c. bias potential is provided for the transistors as shown. In the above circuit either *A* or *B* is in a conducting state depending



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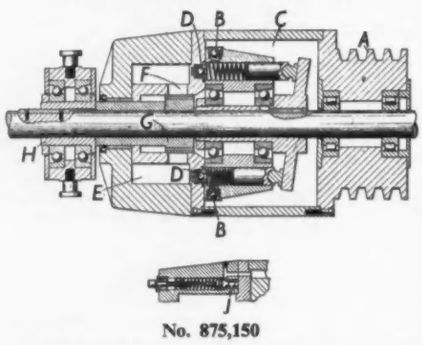
on the potential applied to the base of *A*. To determine the conductive state of the circuit the base of *A* is connected to a potential divider circuit provided by resistor *G* and a photo-transistor *H*. The potential of the base of *A* will thus depend on the intensity of the light reaching *H*. In operation with light lower than a predetermined value reaching *H*, the potential of the base of *A* will be such that the transistor conducts and *B* is cut off, relay *E* being de-energised. When the light reaching *H* increases, the emitter-base potential of *A* will be reduced and when this potential reaches the threshold value *A* is cut off and *B* conducts and energises relay *E*. The intensity of light necessary to operate the relay can be determined by the setting of resistor *G*. Each time that the light intensity passes through the predetermined value the state of *E* is changed and the relay if desired can be in the form of an electromagnetic counter. An alternative arrangement with three transistors to produce a higher current to operate the relay is illustrated in the specification.—*August* 16, 1961.

POWER TRANSMISSION

875,150. June 8, 1960.—CLUTCHES, Tube Making Machines, Ltd., Blaenrhondda, Glamorgan, Wales. (*Inventor : Martin Westbury Wilson.*)

One specific embodiment of clutch according to the invention is described by way of example, with reference to the accompanying drawing. The input member of the clutch is a shaft mounted for rotation in a casing, constituting the output member of the clutch and carrying a gear wheel or sprocket *A* for



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transmitting motion to the driven mechanism. The shaft carries a swash plate coacting with a number of pistons reciprocating in cylinders in a block fixed to the casing. A spring in each cylinder holds the associated piston in engagement with the swash plate. In the side wall of each cylinder is a spring-loaded inlet valve *B* through which liquid can enter the cylinder from a low pressure chamber *C* in the casing. In the end of each cylinder is a discharge valve *D*, through which liquid may be discharged into a high pressure chamber *E*. Two passages are provided for the flow of liquid from the high pressure chamber to the low pressure chamber. One passage *F* is controlled by a sleeve valve *G* mounted to slide on the input shaft and fixed to a trunnion block *H*, the trunnions of which are pivotally mounted on a lever (not shown) which can be moved to open or close the sleeve valve. The other passage *J* (lower view) is controlled by a spring-loaded relief valve, the loading of which is adjustable by means of a nut. With the sleeve valve closed and the torque applied to the input shaft less than that which will establish in the high pressure chamber a hydraulic pressure sufficient to open the relief valve *J*, the liquid is trapped in the cylinders, resulting in a positive drive. When the torque exerts a force sufficient to open the relief valve *J*, the flow of liquid permitted, allows slip in the clutch. When the sleeve valve is open, the relief valve is by-passed and a free passage of liquid is permitted, thus de-coupling the drive. Constant torque variable speed drive can be arranged by controlling the position of the sleeve valve by a centrifugal governor or other suitable means.—*June* 8, 1960.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

ELECTROPLATED COATINGS ON THREADED COMPONENTS PART 1 : CADMIUM ON STEEL COMPONENTS. PART 2 : ZINC ON STEEL COMPONENTS.

No. 3382 : Parts 1 and 2 : 1961. Price 7s. 6d. The two parts of this new standard have been published as one booklet, dealing with thicknesses of plating which, without preventing the assembly of threaded components, will ensure satisfactory protection against corrosion. Notes explain the problems associated with the electroplating of threaded components and the need for special procedures for thickness specification, inspection sampling and thickness determination. As well as specifying plating thicknesses, sampling and other inspection procedures, and methods of thickness determination, the publication lays down requirements for the purity of the plating, for reduction of hydrogen embrittlement for finish and appearance of plated surfaces, and for passivation. In the case of cadmium plating, requirements are also laid down for adhesion and for freedom from gross porosity. Tables of surface areas of standard screws, bolts and nuts are given as a guide to electroplaters, so that they may estimate the conditions of current and plating time needed to obtain the required deposit thickness, and also to assist in the estimation of average thickness on plated components.

The plating thickness laid down are intended for components having threads of basic major diameters from 0·060in to $\frac{3}{4}$in inclusive. The plating thicknesses specified will be adequate for most purposes, but under severe conditions, greater protection may be needed. In such cases, reference should be made to Part 7 B.S.3382, to be published in due course under the title " Thicker Plating for Steel Components." Other parts will deal with nickel and nickel/chromium on steel components, nickel and nickel/chromium on brass components, tin on brass components and silver on brass components.

DIRECT READING PERSONAL DOSEMETERS

No. 3385 : 1961. Price 3s. This new British Standard lays down requirements for direct reading personal dosemeters for X- and gamma-radiation. These instruments—a common type of which looks like a fountain pen—fit into the pocket. Obviously, it is essential that these instruments should be robust and accurate and the requirements of B.S.3385 are intended to ensure that they are. A note in the foreword draws attention to the effect of beta radiation on measurements of gamma radiation dose and ecommends that when the dosemeter is used in the presence of beta radiation, an appropriate sleeve should be fitted to the instrument. It also points out that unsealed instruments may be seriously affected by large changes in humidity, changes in atmospheric pressure and by the presence of significant concentrations of radioactive or ionised gases. In such circumstances, it is recommended that a sealed instrument should be used. A companion standard, for film badges, is in course of preparation.

B.S.3385 is the first British Standard to be prepared under the authority of the newly-formed Nuclear Energy Industry Standards Committee of the British Standards Institution.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, Sept. 15.—STOKE AND CREWE BRANCH : Grand Hotel, Hanley, " Electronic Controls and Photo-electric Equipment," G. I. G. Ive, 7.30 p.m.

Mon., Sept. 18.—BRISTOL AND WEST OF ENGLAND BRANCH : Grand Hotel, Bristol, Chairman's Address and " Trends in Technical Education," E. J. Mathieson, 8 p.m. ★ ESSEX BRANCH : White Hart Hotel, Tindle Street, Chelmsford, " The A.S.E.E. : Its Work and its Future," E. A. Broomfield, 7.45 p.m.

Tues., Sept. 19.—LEICESTER BRANCH : Westcotes Constitutional Club, 124, Wilberforce Road, Leicester, " Subscriber Trunk Dialling," C. G. Lloyd, 7.30 p.m. ★ OXFORD AND DISTRICT BRANCH : Board Room, Employment Exchange, St. Aldates, Oxford, " Present-day Applications and Recent Developments in Water Heating," 7.30 p.m. ★ READING AND DISTRICT BRANCH : Caversham Social Club, Caversham, Reading, Programme of Stereo-recordings, 7.30 p.m. ★ YORK BRANCH : Royal Station Hotel, York, " Electric Floor-warming," R. Bradbury, 7.30 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Tues., Sept. 26.—SOUTHERN SECTION : Technical College, Farnborough, Chairman's Address, " Lighting—Facts and Fancies," W. A. Gambling, 7 p.m.

Wed., Sept. 27.—Education and Training Committee, University College, London, All-day Symposium, " The New Graduateship Syllabus and the Institution's Recommendations for Practical Training," 10.30 a.m. ★ TELEVISION GROUP : London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, Papers on " Some Recent Developments in Television Tape Recording," P. E. Axon, K. Machein and Aubrey Harris, 6 p.m. ★ WEST MIDLANDS SECTION : College of Technology, Wolverhampton, " The Single Crystal Circuit," D. H. Roberts, 7.15 p.m.

ILLUMINATING ENGINEERING SOCIETY

Tues., Sept. 19.—STOKE-ON-TRENT GROUP : North Staffs Hotel, Stoke-on-Trent, " The I.E.S. Code," P. Hartill and G. O. Edwards, 6 p.m.

Tues., Sept. 26.—LEICESTER CENTRE : Demonstration Theatre, East Midlands Electricity Board, Charles Street, Leicester, Chairman's Address, H. R. Ruff, 6.15 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Tues., Sept. 19.—SLOUGH SECTION : Lecture Theatre, High Duty Alloys, Ltd., Buckingham Avenue, Slough, Brains Trust, " Castings for the Commercial Market," D. C. Hynes, M. R. Maggs, H. P. Mott and R. G. Britton, 7.30 p.m.

Thurs., Sept. 28.—LONDON BRANCH : National Liberal Club, Whitehall Place, London, S.W.1, Talk by the President, " My Job," A. R. Parkes, and Film Show, 7.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Thurs., Sept. 21.—WEST MIDLANDS SECTION : College of Further Education, Green Close Lane, Loughborough, " Diesel Electric Installation for Propulsion and Cargo Handling of the Bulk Cement Carrier ' John Wilson ',' H. E. Muckley and J. G. Derrington, 6 p.m.

Tues., Sept. 26.—SOUTHERN JOINT BRANCH : Royal Beach Hotel, South Parade, Southsea, Joint meeting with the Royal Institution of Naval Architects, " High Speed Craft," Cdr. P. Du Cane, 7.30 p.m.

INSTITUTE OF NAVIGATION

Tues., Sept. 26.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, All-day meeting, " The Transit Navigation Satellite System," 10 a.m.

INSTITUTE OF PETROLEUM

Wed., Sept. 20.—61, New Cavendish Street, London, W.1, " Airborne Techniques in Petroleum Exploration," W. Domzalski, 5.30 p.m.

INSTITUTE OF PHYSICS AND THE PHYSICAL SOCIETY

Thurs. and Fri., Sept. 21 *and* 22.—Department of Physics, University College of North Wales, Bangor, Joint conference on " Radiospectroscopy of Solids," Guthrie Lecture to be delivered during the conference—" The de Haas-van Alphen Effect and the Electronic Structure of Metals," D. Shoenberg.

Thurs. and Fri., Sept. 28 *and* 29.—ELECTRONICS GROUP : Assembly Room, Town Hall, Leamington Spa, Joint conference on " The Physics of Gas Discharge Devices."

INSTITUTE OF WORK STUDY

Fri., Sept. 29 *to Sun., Oct.* 1.—College of Aeronautics, Cranfield, Annual Conference, " The Scope for Investigation into Office and Sales Procedure."

INSTITUTION OF HEATING AND VENTILATING ENGINEERS

Wed., Sept. 27 *to Wed., Oct.* 4.—Olympia, London, S.W.7, International Conference on Heating, Ventilating and Air Conditioning to be held during the Exhibition of Heating, Ventilating and Air Conditioning Equipment.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Tues., Sept. 26.—Lecture Hall, Institution of Mechanical Engineers, 1, Birdcage Walk, London, S.W.1, Ordinary General Meeting, Presidential Address, J. F. Harrison, 5.30 p.m.

INSTITUTION OF PLANT ENGINEERS

Wed., Sept. 20.—KENT BRANCH : South Eastern Gas Board Lecture Hall, 95, High Street, Rochester, " Timber—Its Uses and Characteristics in Plant Engineering," R. P. Wood, 7 p.m.

Thurs., Sept. 21.—BLACKBURN BRANCH : Castle Hotel, Blackburn, " Shell Boiler Developments," A. D. C. Gunn, 7.30 p.m.

Mon., Sept. 25.—WEST AND EAST YORKSHIRE BRANCH : Houldsworth School of Applied Science, The University, Leeds, " The Construction of Bradwell Heat Exchangers," J. Shaw and G. Cain, 7.30 p.m.

Tues., Sept. 26.—SOUTH WALES BRANCH : South Wales Institute of Engineers, Park Place, Cardiff, " Industrial Use of Gas," W. H. Tarn, 7.30 p.m.

Thurs., Sept. 28.—MERSEYSIDE AND NORTH WALES BRANCH : Exchange Hotel, Liverpool, " The Natural Ventilation of Industrial Buildings," F. E. Grandidge, 7.15 p.m. ★ SHEFFIELD BRANCH : Grand Hotel, Sheffield, " Industrial Relations," W. Carron, 7.30 p.m.

Fri., Sept. 29.—BIRMINGHAM BRANCH : Imperial Hotel, Temple Street, Birmingham, " The Planning, Application and Maintenance of Industrial Lighting," V. Heydon, 7.30 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Tues., Sept. 26.—Manson House, 26, Portland Place, London, W.1, " Underground Gasification of Coal—Some Features of Instrumentation," A. E. Balfour, and " Trends in Mining Instrumentation," A. E. Bennett, 6.30 p.m.